BEDIENUNGSANLEITUNG

Leader

LBO - 5880

LBO – 5880

PROGRAMMABLE OSCILLOSCOPE INSTRUCTION MANUAL

[Notice]
This manual is subject to change without prior notice.
Also, the program stored in internal memory (ROM) of this programmable oscilloscope is used to govern its basic operations and may be updated without prior notice to reflect product improvements or changed specifications.
The version number of the ROM program can be determined from Section 10.10 of this manual.

TABLE OF CONTENTS

1. INTRODUCTION

The LBO-5880 is a dual trace, delayed-sweep, programmable oscilloscope that allows all scope mode settings. This includes variable controls which are easily stored in a 100-address internal memory and can be recalled whenever needed.
It features 5 mV/div (30 MHz) and 1 mV/div (20 MHz: MAG × 5), and a maximum sweep rate of 20 ns/div (MAG × 10), with a 6-inch rectangular metal-back CRT with a high-brightness, internal graticule.
The waveform clamping function of the LBO-5880 and its ability to set two marker cursors for waveform amplitude adjustment provide an ideal measuring instrument for use in the production and servicing of TV sets and VTRs.

2. FEATURES

2.1 Oscilloscope Section

- The 6-inch rectangular CRT with an internal graticule, supported by regulated high-acceleration voltage power supplies, yields accurate, error-free measurement reading. The metal-backed CRT also offers added intensity, assuring adequate brightness for delayed sweeps.
  Scale illumination and beam rotation functions are also provided.
- A single-key selection of high-sensitive 1 mV/div (20 MHz) facilitates the measurement of ripples in regulated power supplies and weak signals in biological and other research activities.
- The delayed sweep function, independent A and B trigger selection function, and separate external trigger input terminals support a wide range of observations.
- The maximum sweep rate can be quickly magnified to 20 ns/div by the 10 (times) magnifier, thus enabling the disply of 30 MHz waveforms in six sweep periods on the screen.
- The ALT trigger function yields static waveforms of two types of signals with different timing relations.
- A built-in synchronous sampling circuit eases synchronization with TV composite video signals. Since the vertical (VIDEO-V) and horizontal (VIDEO-H) sweep periods are selectable regardless of the TIME/DIV switch setting, the waveform in the horizontal sweep period can be synchronized and observed with the vertical sweep period.
- Variable hold-off time enables video signals and pulse strings from computers (such as digital word pulses) to be observed in stabilized periods.
- The B ENDS A function lessens flickering during magnified delayed sweeps.
- ADD and CH-2 polarity selections make it possible to observe the sum of difference between two signals and to also display an accurate picture of push-pull signals.
- Signals applied to CH-1 can be isolated from the vertical preamp via a buffer. Since this output is about 0.1 V p-p per division on the screen, the LBO-5880 can be used as a super-high sensitive counter when this output is connected to a counter.
- The LBO-5880 can be switched by a one-key operation to an X-Y oscilloscope having CH-1 as the X-axis and CH-2 as the Y-axis.
- Extensive use of custom ICs establishes enhanced reliability.
- The GND TEST switch allows checking the GND level at a single touch, independently of the program.
- Each function mode of the oscilloscope is constantly displayed on a panel LED. This LED display can be suppressed by a switch.

2.2 **Memory Section**

- The memory addresses are organized into 100 steps, numbered from 0 to 99. The stored program is protected by a battery backup.
- The BEGIN and END addresses can be freely set from address 0 to adress 99, so that the program stored within this range can be recalled for use in a product tuning line, for example, as often as desired. The BEGIN and END addresses, once set, are protected by backup memory.
- Programmed data can be transferred to another LBO-5880 (SAVE) or data can be received from another LBO-5880 (LOAD).
- Program insertion, deletion, and exchanging are provided as memory editing functions to simplify program editing to meet changing process requirements.
- All oscilloscope functions, including variable controls, are programmable, with the exception of focus, astigmatism, rotation, and illumination.
  Variable data can also be stored as independent data, ranging from address 0 to address 99.
- Whenever an operator error occurs, the corresponding error number is displayed to alert the operator. In this way, continued use of the oscilloscope will be inhibited until the error is recovered.
- Program contents can be printed on an external printer.
- The INC, DEC, and BEGIN functions can be remote-controlled by attaching the optional control box (LBO-5880-03) to the front panel EXT INC INPUT jack.
  The LBO-5880 can be interlocked with an external instrument since its addresses can be controlled with externally supplied binary or BCD codes.
  During LBO-5880 memory access, binary and BCD addresses code signals are externally supplied for the external device to be able to read the address.
- As a 64-bit (8 bits × 8) external control memory is provided and simple external circuit is installed, the 64 bits can be externally controlled.
- Since the oscilloscope functions can be selected by transmitting data from an external controller (such as a microcomputer), the LBO-5880 can be totally operated as a remote-controlled oscilloscope (including variable controls.)
- Hardware self-diagnostics simplifies the process of checking for internal errors.
- Memory write protection prevents inadvertent deletion of important programs.

3. SPECIFICATIONS

3.1 **Oscilloscope Section**

CRT display	150 mm rectangular, internal graticule Metal-backed, % scale	
	Acceleration voltage	7 kV/2 kV regulated
	Effective display area	8 × 10 div (1 div = 10 mm)
	Beam rotator	Adjustable from front panel
	Scale illumination	
	Intensity modulation	Blanked by TTL level signals

In the specifications below, ratings marked with * are guaranteed values at +15 ~ +35°C.

Vertical Amplifier (for both CH-1 and CH-2)

Deflection sensitivity	5 mV/div ~ 2 V/div (entire bandwidth)
	1 mV/div (20 MHz: MAG × 5 ON)
	1-2-5 sequence, 9 steps, and continuous adjuster
Calibration accuracy	*±3% (±5%: MAG X 5 ON)

Frequency characteristics	*DC ~ 30 MHz (REF. 8 div) – 3 dB (DC ~ 20 MHz (REF. 8 div) – 3 dB: MAG × 5 ON) AC coupling: Low-path 10 Hz ~ – 3 dB
Rise time	*12 ns (18 ns: MAG × 5 ON)
Input impedance	1 MΩ ± 1.5%, 35 pF within ± 5 pF (Tolerance: within ± 2 pF)
Input coupling	AC, GND, DC
Maximum input voltage	200 V (p-p + DC)
Display modes	CH-1, CH-2, ALT, CHOP, ADD, X-Y, CH-1 CURSOR ON, CH-2 CURSOR ON
Polarity invert	CH-1 INVERT, CH-2 INVERT
CH-1 output	Approx. 0.1 V/div (into 50Ω) DC ~ 30MHz, – 3 dB
Cursors	Upper and lower cursors (Only one trace can be viewed while cursors are displayed.)
Pedestal clamps of composite video signal	+ Clamp: Clamped to + sink waveform pedestals. – Clamp: Clamped to – sink waveform pedestals.

Horizontal Amplifier

Sweep Method	Trigger sweep, automatic trigger sweep, continuous delayed sweep, and trigger delayed sweep
A sweep time	0.2 μs/div ~ 200 ms/div 1-2-5 sequence, 19 steps, and continuous adjuster
B sweep time	0.2 μs/div to 200 ms/div 1-2-5 sequence, 19 steps, and continuous adjuster
Calibration accuracy	*± 3% (for both A and B)
Hold-off variable	One sweep or more
Setting accuracy of delay time position	approx. ± 3%
Magnifier	× 10 ± 5%
Maximum sweep time	20 ns/div (MAG × 10 ON)
Synchronization signal	
source A :	LINE, CH-1, ALT, CH-2 and EXT.
source B :	B START AFTER DELAY, CH-1, ALT, CH-2 and EXT
Synchronization	
coupling A :	AC, HF-REJECT, LF-REJECT, DC, VIDEO H and VIDEO V.
source B :	AC, HF-REJECT, LF-REJECT, DC, VIDEO H and VIDEO V
Synchronization slope A	+, –
" B	+, –
Synchronization sensitivity	

	Bandwidth	INT.	EXT.
NORM	30 Hz ~ 10 MHz	0.5 div	0.2 Vp-p
	2 Hz ~ 30 MHz	1.5 div	0.6 Vp-p
AUTO	30 Hz ~ 10 MHz	0.5 div	0.2 Vp-p
	30 Hz ~ 30 MHz	1.5 div	0.6 Vp-p

TV synchronization	Synchronizing composite video signals. The slope switch is selected according to video signal polarity.
X-Y mode	(X = CH-1, Y = CH-2)
Sensitivity	Same as the Vertical Amplifier
X-axis bandwidth	DC or 10 Hz ~ 1 MHz – 3 dB (REF. 8 div)
X-Y phase	Less than 3° at 100 kHz
Calibrator	
Output voltage	0.5 Vp-p, *± 2%
Frequency	Approx. 1 kHz, square wave

3.2 Memory Section

Program address	0 ~ 99 (100 addresses)
Internal memories	2,048 words by 8 bits static CMOS RAM × 5 (Program backup, four, 8K bytes Internal system, one, 2K bytes)
Built-in battery	NiCd backup battery, 3.6 V Provides one-month's memory backup when fully charged at 90 mAh. The built-in battery is trickle-charged during system operation and can be fully charged over two days (for about 25 hours).
Address display	7-segment two-digit LEDs display addresses 0 ~ 99. The address signals during memory access can be transferred to the rear panel I/O port in binary BCD cords.
EXT address control	Address INC, DEC, and BEGIN can be remote-controlled by using an optional hand switch (LBO-5880-03 control box).

Operating modes

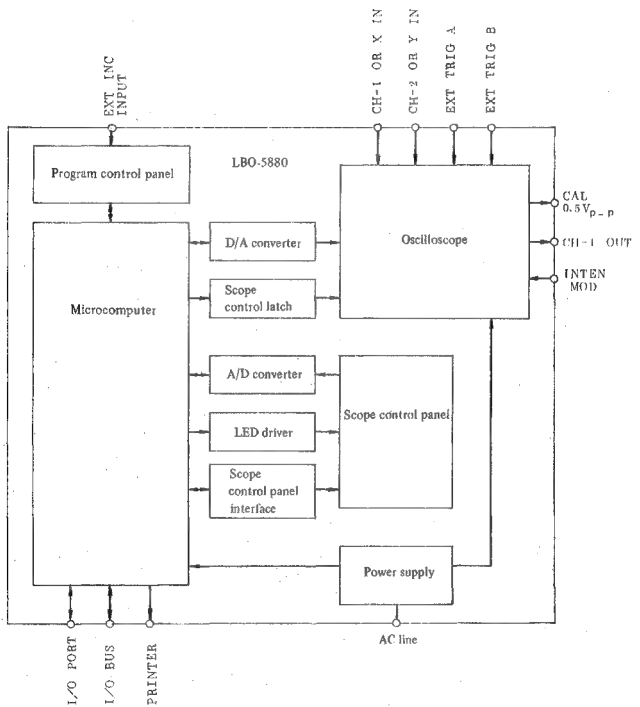
SW mode	Major functions
SET	BEGIN and END address setting, setting/resetting of memory write protection
PROG	Program entry, insertion, deletion, exchanging, recall, and sample program call
CHANGE VAR'S	Alteration of variable knobs data
RUN PROG	Program call
MANUAL	Operation as an ordinary oscilloscope without using memory
REMOTE	Control by externally supplied address data
SAVE	Program transfer to another LBO-5880
LOAD	Program transfer from another LBO-5880
PRINT	Printing of program data on an external printer
FUNC 1	Automatic address incrementation
FUNC 2	External oscilloscope control, and checking programs
FUNC 3	Checking programs, and other options

Memory functions	Can be memorized for all switch modes (except memory control SW, GND TEST SW and LED OFF SW), CH-1 POS, CH-2 POS, H POS, A TIME VAR, B TIME VAR, DELAY TIME POSITION, CH-1 VAR, CH-2 VAR, UPPER CURSOR, LOWER CURSOR, A HOLD OFF, A LEVEL, B LEVEL, INTEN, Each variable knobs data has Resolution 1024 (10 bits).
External connectors	
I/O bus	24 pins ○ External device control (An additional circuit is required: 8 bits × 8, 64 bits maximum) ○ Probe selector (LBO-5880-02) ○ GP-IB (scheduled)
I/O port	37 pins ○ Program transfer ○ Address output ○ Address input (address control) ○ Oscilloscope control by external data
Printer	14 pins ○ Program data printing (on a Centronix compatible printer)

3.3 Miscellaneous

DC fan	DC 24V, 0.09A
Supply voltage	100V (also changable to 117V, 220V, and 240V by voltage selector)
Power consumption	85W
Dimensions and weight	320(W) × 200(H) × 400(D), 11kg
Accessories	Fuse, ... 1 Instruction manual 1
[Options]	
Printer cable	LC-2065 (1.5m)
Transfer cable	LC-2066 (2m)
Probe	LP-16BX
Control box	LBO-5880-03
I/O CARD	LC-2330 (Special for NEC COMPUTER, PC8001 MKII & PC8801MKII)

4. BLOCK DIAGRAM

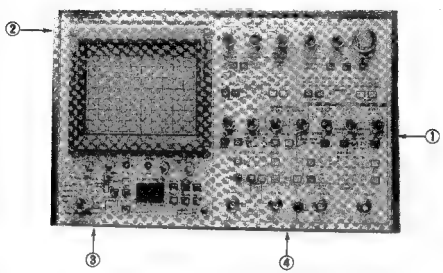


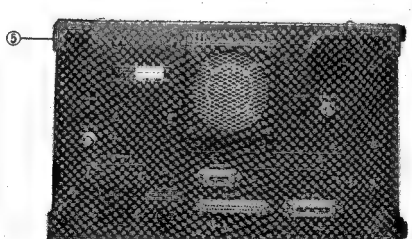
Schematic diagram

5. PANEL DESCRIPTION

In this manual, circled figures and the names that follow them denote switches, controls, I/O connectors, indicators, or other functions.

5.1 General Appearance ① ~ ⑤





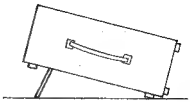
① Handle
Used to carry the LBO-5880 oscilloscope.

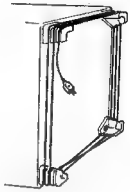
② Side rubber legs
Four rubber legs support the oscilloscope placed on the floor or sideways after being held by the handle.

③ Bottom rubber legs
Four rubber legs support the oscilloscope when positioned on the floor.

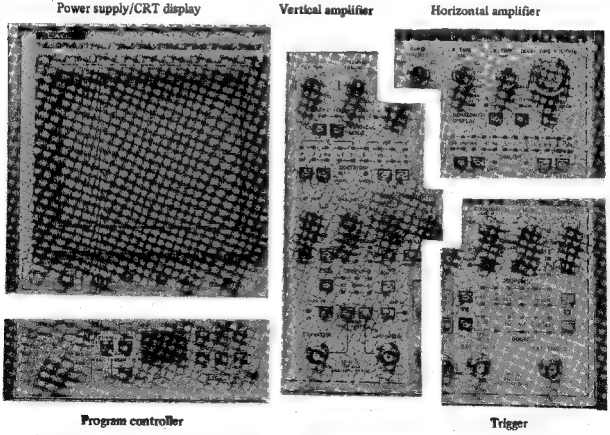
④ Tilt stand
Used to raise the front panel portion of the oscilloscope when it is positioned horizontally. Store it when not in use.

⑤ Stand legs and power supply cord reel
Four stand legs support the oscilloscope when positioned vertically. The oscilloscope, however, cannot be positioned vertically with the cable being connected to the rear panel connector. The power supply cord can be wound around the stand legs as shown to the right.





5.2 Front Panel

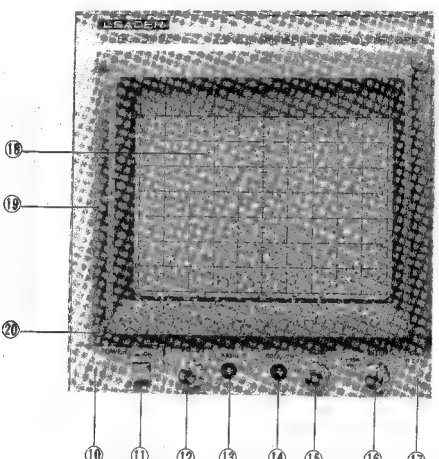


The LBO-5880 front panel is generally classified into the following five parts:

(1) Power supply/CRT display
(2) Program controller
(3) Vertical amplifier
(4) Horizontal amplifier
(5) Trigger

These facilities can also be found on a usual dual-trace delayed sweep oscilloscope, except for program controller unique to a programmable oscilloscope.

5.3 Power Supply/CRT Display Block, (10) ~ (20)



The power supply/CRT display provides functions relating to the power switch, CRT (cathode ray tube), and CAL output.

(10) Power indicator lamp
LED (light-emitting diode) indicating that the power to the oscilloscope is on.

(11) POWER switch
Power on/off push switch. Push the switch (▂ ON) to turn on the power to the oscilloscope, push it again (▆ OFF) to turn the power off.

(12) FOCUS (Not programmable)
Focus control used to obtain a clear display of waveforms on the CRT screen. Once FOCUS 12 is set at an optimal point at about the center of INTEN (16), automatic tracking keeps the focus in that condition even with changes in intensity.

When excessive intensity outside the automatic tracing range is desired, FOCUS (12) requires readjustment to suit the intensity level.

Adjust ASTIG (13) when the waveform on display is not in focus as a whole.

(13) ASTIG (Not programmable)

ASTIG control is used to obtain a clear display of waveforms on the CRT, together with FOCUS (12).

(14) ROTATION (Not programmable)

Changing the setting position of the oscilloscope may bring the luminescent line out of level under the influence of the earth's magnetism. By using a screwdriver, adjust ROTATION to move the luminescent line to the center of the internal graticule in parallel with the horizontal scale.

(15) ILLUM (Not programmable)

Illuminates the scale line for easy reading during viewing waveform amplitude. Turn clockwise to brighten the scale line.

(16) INTEN

Intensity control is used to adjust the brightness of waveforms on display. Turn clockwise to increase intensity, counterclockwise to reduce it.

Although other PTP controls are suppressed during program call, the INTEN control alone is always controllable, because the luminescent line would be totally suppressed if INTEN had been turned fully counterclockwise.

The intensity level in effect represents the sum of the intensity level programmed in the PROG mode, plus the intensity level at the INTENSITY position (±0 at the center) used when the program is called. Therefore, if INTEN has been set in the clockwise direction from the center, the program is called on the display at the intensity level higher than the programmed level.

(17) CAL 0.5 Vp-p (Calibration wave)

Amplitude and probe calibration signal output pin at a frequency of 1 kHz.

(18) Scale

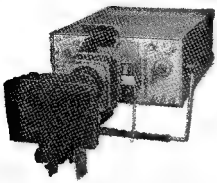
The scale is directly calibrated in the internal CRT surface with eight divisions horizontally and 10 divisions vertically (1 division = 10 mm), with a 0.2 div auxiliary scale in the center.

Vertical voltage sensitivity and horizontal sweep time, both adjusted with respect to this scale, correspond to VOLTS/DIV. and TIME/DIV. on the scale, respectively. Moreover, divisions of 0, 10, 90, and 100% are used to measure pulse waveform rise and fall times.

(19) Window frame

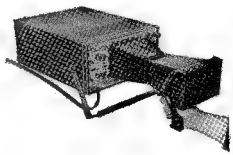
A shading hood and a waveform camera can be attached to this part. The LH-2015 (option) is used as the shading hood. See below for waveform cameras.

- Closeup device for single-lens reflex cameras and polaroid CRT cameras (M-75D) (Fixed)



This closeup device is attached to the oscilloscope window frame to photograph waveforms on display.

- Handy CRT polaroid CRT camera (M-085D) and closeup hood



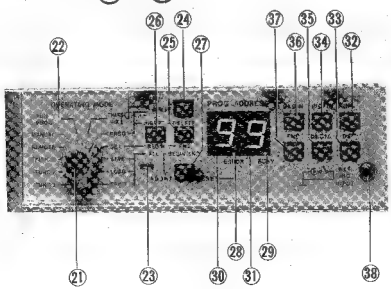
A camera set with a replaceable hood that enables waveform shooting on an oscilloscope of any design with one hand.

Fixed type	Product name		Type
	Polaroid CRT camera		M-75D
	Closeup device (Fixed)		5R32
	Data projector		6238
	Base (LBO-518, 517, 525L, 524, 523, 522, 51MA, 5850A, 5851A, 5860A, 5861A, 5880)		43179, B
	Case		–
Handy type	ACMEL CRT camera		M-085D
	Closeup hoods	LBO-518, 517, 525L, 524, 523, 522, 51MA, 5850A, 5851A, 5860A, 5861A, 5880	#85-23

* For a detailed catalog of oscilloscope waveform cameras or for inquiries, call
Asanuma Trading Co. (JAPAN)
Phone Tokyo (03) 264-5111
Osaka (06) 538-3114

(20) Window frame mouting screws
Remove these four screws to replace filters.

5.4 Program Controller Block, (21) ~ (38)



The program controller includes an operating mode selector, an editor, and an address controller.
These functions are unique to the programmable controller.

5.4.1 Operating modes

(21) OPERATING MODE selector

This is a 12-position rotary switch used to select operating modes for the LBO-5880. The following 12 operating modes are selectable:

(1) MANUAL
The LBO-5880, like an ordinary oscilloscope, is operated manually.

(2) RUN PROG
A stored program can be called and executed.

(3) CHANGE VAR'S
Stored programs can be altered or updated with regard to its variable (VAR), position (POSITION), and level (LEVEL).

(4) PROG
An oscilloscope operation can be set up and stored in memory (WRITE). Settings of all controls, except FOCUS (12), ASTIG (13), ROTATION (14), and ILLUM (15), and the selector, can be stored at the 100 addresses from address 0 to address 99.
The program contents of a selected address can also be altered or updated in the PROG mode.

(5) SET
The BEGIN and END addresses are set. The address selected by using the address controller can be set by pressing the BEGIN key (26) and/or END key (25). By using this function, addresses 0-99 can be split into desired intervals for use.

(6) SAVE
Programs can be transferred to external equipment (another LBO-5880).

(7) LOAD
Programs can be received from external equipment (another LBO-5880).

(8) PRINT
Program contents can be printed on an external printer.

(9) FUNC 3 (Function 3)

(10) FUNC 2 (Function 2)

(11) FUNC 1 (Function 1)
FUNC 1 through FUNC 3 are optional modes, or modes used for adjustment to special specifications or during production.

(12) REMOTE
Programs addressed by address data (binary or BCD) that are received externally can be automatically called. Hence, remote control by addressing is possible.

(22) RUN PROG mode indicator lamp
Goes on when OPERATING MODE (21) is set to RUN PROG.

5.4.2 Editor

(23) Buzzer
Sounds at key entry or to indicate an error.

(24) WRITE key
Used to write program alterations or additions to memory while OPERATING MODE (21) is set to CHANGE VAR'S or PROG.

WRITE key (24) does not increment the address in the CHANGE VAR'S mode. In the PROG mode, however, WRITE key (21) increments the address after writing the current status to memory, & waiting the indicated next address.

(25) INSERT, END, BEGIN/END key

Key differnt functions depending on the OPERATING MODE (21) setting.

(1) As the INSERT key when OPERATING MODE (21) is PROG, allows insertion of new program data at the current address by moving all subsequent addresses backward until the END address by one address.

(2) As the END key when OPERATING MODE (21) is SET, sets the value displayed by PROG ADDRESS (30) and (31) as the END address.

(3) As the BEGIN/END key when OPERATING MODE (21) is SAVE, LOAD, and PRINT,

SAVE mode: Transfers a program between the BEGIN and END addresses.

LOAD mode: Receives a program between the BEGIN and END addresses.

PRINT mode: Transfers program data between the BEGIN and END addresses to an external printer.

(26) DELETE, BEGIN, SINGLE key

This key has different functions depending on the OPERATING MODE (21) setting.

(1) As the DELETE key when OPERATING MODE (21) is PROG, delets the address at the current address, moving all subsequent addresses forward until the END address by one address. The END address is decremented after this operation.

(2) As the BEGIN key when OPERATING MODE (21) is SET. sets the value displayed by PROG ADDRESS (30) and (31) as the BEGIN address.

(3) As the SINGLE key when OPERAING MODE (21) is SAVE, LOAD, and PRINT,

SAVE mode: Transfers program at the current program address only.

LOAD mode: Receives the program at the current program address only.

PRINT mode: Transfers program data at the current program address only.

(27) ABORT, RESET key

Used to clear error displays or terminate operations.

(28) ERROR LED

Goes on when an error occurs during mode selection or during data transmission or reception. The error number is displayed by the 7-segment LEDs (30) and (31). See 12, "Error Messages" for error numbers and their definitions.

(29) BUSY LED

Goes on when the CPU is executing internal processing. It rejects all memory control keys while this LED is on.

(30), (31) PROG ADDRESS LEDs

Displays the current program address normally, or an error number when ERROR LED (28) is on.

The following keys perform an auto-repeat function when kept pressed:

(32) INC key

Increments the program address by one address.

(33) DEC
Decrements the program address by one address.

(34) INC 10 key
Increments the program address by 10 addresses.

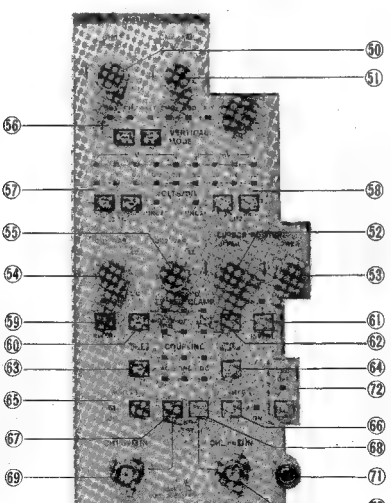
(35) DEC 10 key
Decrements the program address by 10 addresses.

(36) BEGIN key
Calls the BEGIN address of a program. (Press this key to determine the BEGIN address.)

(37) END key
Calls the END address of a program. (Press this key to determine the END address.)

(38) EXT INC INPUT
The INC function can be performed remotely by attaching an external key to this jack. This key can be operated in the same way as INC key (32). See 9.14 for further details. The INC, DEC, and BEGIN functions can be remote-controlled by using the option control box (LBO-5880-03).

5.5 Vertical Amplifier, (50) ~ (72)



Note: Controls marked with PTP are programmable only when pulled.
When pushed, these controls are controlled by data stored in memory.

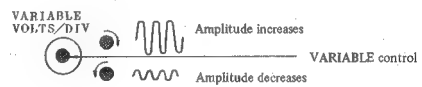
(50) ↕ (Vertical position control)
Turn this control clockwise to move the CH-1 waveform up, counterclockwise to move it down.

(51) [Y] ↕ (Vertical position control)
Turn this control clockwise to move the CH-2 waveform on display up, counterclockwise to move it down.

(52) ↕ Upper cursor position control
Turn this control clockwise to move the upper cursor upward, counterclockwise to move it downward. The cursor is displayed only when VERTICAL MODE (56) is set to CURSOR ON.

(53) ↕ Lower cursor position control
Turn this control clockwise to move the lower cursor upward, counterclockwise to move it downward. The cursor is displayed only when VERTICAL MODE (56) is set to CURSOR ON.

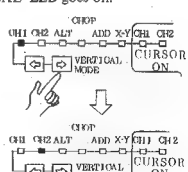
(54) VARIABLE (CH-1 or [X] sensitivity adjuster)
Vertical sensitivity adjuster permits attenuations of the indicated values in the VOLTS/DIV ranges by 1/2.5 or less.



For measuring voltages by using the voltage sensitivity indicated in VOLTS/DIV, turn the VARIABLE control fully clockwise to CAL'D until a click sounds.
If the VARIABLE control is not set to CAL'D, the red UNCAL LED goes on.

(55) VARIABLE (CH-2 or [Y] sensitivity adjuster)
Vertical sensitivity adjuster permits attenuations of the indicated values in the VOLTS/DIV ranges by 1/2.5 or less. For measuring voltages by using the voltage sensitivity indicated in VOLTS/DIV, turn the VARIABLE control fully clockwise to CAL'D until a click sounds.
If the VARIABLE control is not set to CAL'D, the red UNCAL LED goes on.

(56) VERT MODE
Selects dual-trace display modes.
As shown at right, mode changes are effected by using two key switches.
The [⇨] key changes the dispaly modes in the right direction, the [⇦] key changes the display modes in the opposite direction.



CH-1:
Only the input signal to CH-1 is displayed. To synchronize with an internal signal, set TRIG SOURCE select switch (99) to CH-1. The oscilloscope can be used in a mode similar to high sensitivity external synchronization by applying a trigger signal to CH-2, and by setting TRIG SOURCE select switch (99) to CH-2.

CH-2:

Only the input signal to CH-2 is displayed. To synchronize with an internal signal, set TRIG SOURCE select switch (99) to CH-2. The oscilloscope can be used in a mode similar to high sensitivity external synchronization by applying a trigger signal to CH-1 and setting TRIG SOURCE select switch (99) to CH-1.

ALT (Alternate display):

When a dual trace display is desired, set this control to ALT. The oscilloscope will alternately display the trace on CH-1 and that on CH-2 during each sweep of TIME. Flickering can be suppressed by using the oscilloscope in an high-speed sweep range above 0.5 ms/div.

CHOP (High-speed switching display):

When a dual trace display is desired, set this control to CHOP, and the oscilloscope will display the dual traces in dotted lines by high-speed switching square waves at approximately 250kHz, regardless of the TIME setting. Continuous dual traces can be observed with little flickering by using the oscilloscope in a low-speed sweep range below 0.5 ms/div.

CH-1 CURSOR ON (CH-1 and cursor display):

The input signal to CH-1 and the upper and lower cursors are displayed. The cursors can be conveniently used as tuning markers since their positions can be freely set by using cursor position controls (52) and (53).

ADD (Addition):

The input signals to CH-1 and CH-2 are algebraically and displayed. They can be subtracted by setting the CH-2 polarity inversion switch (61) to INV.

CH-2 CURSOR ON (CH-2 and cursor display):

The input signal to CH-2 and the upper cursor are displayed. The cursor can be conveniently used as a tuning marker since its position can be freely set by using cursor position controls (52) and (53).

(57) VOLTS/DIV (CH-1 or X sensitivity selection)

Selects the sensitivity of input signals to CH-1 for (69).

5 mV/div to 2 V/div are selected in nine levels.

For the X-Y operation, this switch is used to select sensitivity for the X-axis.

To measure input signals by using the indicated voltage sensitivity, turn VARIABLE control (54) fully clockwise to CAL'D until a clike sounds. When an input signal has been applied to input pin (69) through a 1/10 attenuation low-capacitance probe, read the measured value by multiplying it by 10 times.

(58) VOLTS/DIV (CH-2 or Y sensitivity selection)

Selects the sensitivity of input signals to CH-2 for (70).

5 mV/div to 2 V/div are selected in nine levels.

For the X-Y operation, this switch is used to select sensitivity for the Y-axis.

To measure input signals by using the indicated voltage sensitivity, turn VARIABLE control (55) fully clockwise to right to CAL'D until a click sounds. When an input signal has been applied to input pin (70) through a 1/10 attenuation low-capacitance probe, read the measured value by multiplying it by 10 times.

(59) CH-1 POL INV. (CH-1 polarity inversion switch)

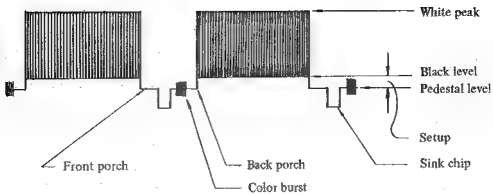
Usually, keep this switch set on the normal position. When it is set to INV (inversion), the polarity of the signal applied to CH-1 is inverted; in other words, the upper part of the input signal becomes negative and the lower part becomes positive.

The yellow INVERT ON LED goes on when this switch is set to INV.

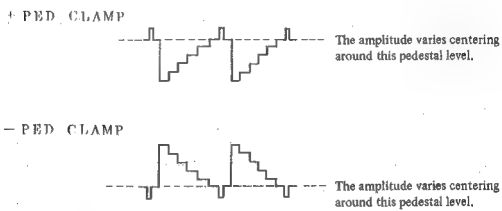
(60) CH-1 TV PED CLAMP

Used to clamp the input signal to CH-1 on the positive or negative side.

Composite TV video signals are typically indicated as follows:



The choice between + and – depends on the direction (polarity) of the sink chip.



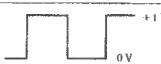
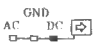
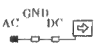
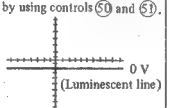
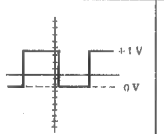
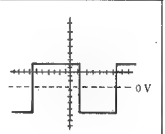
Depending on whether oscilloscope input coupling switches (63) and (64) are set to AC or DC, the video signals can be displayed centering around a fixed pedestal level (at about the zero position when (63) and (64) are set to GND) as long as the video signals are contained.
Hence, this switch can be used to vary the amplitudes of sink chip and video signals separately with respect to the composite signals for adjustment.

(61) CH-2 POL. INV (CH-2 polarity inversion switch)
Usually, keep this switch set to the normal position. When it is set to INV (iversion), the polarity of the signal applied to CH-2 is inverted; in other words, the upper part of the input signal becomes negative and the lower part becomes positive.
The yellow INVERT ON LED goes on when this switch is set to INV.

(62) CH-2 TV PED CLAMP
Used to clamp the input signal to CH-2 on the positive or negative side. See the item of CH-1 TV PED CLAMP (60) for further information.

(63) AC-GND-DC (AC-ground-DC selection), CH-1
Selects the coupling of the input signal applied by vertical amplifier input (69).
The switch rejects DC components by a capacitor when set to AC. When set to GND, the amplifier input is grounded and input pin (69) is open.
See (64) for observation examples.

(64) AC-GND-DC (AC-ground-DC selection), CH-2
Selects the coupling of the input signal applied by vertical amplifier input (70). The switch rejects DC components by a capacitor when set to AC. When set to GND, the amplifier input is grounded and input pin (70) is open.
Observation examples at the respective switch positions (AC-GND-DC) are shown below.

Input signal	 Symmetrical square waves		
(63) and (64) switch positions	 Zero position (0V)	 Distribution of DC voltage can be determined.	 Only changes in AC voltage can be seen.
CRT display waveforms and their positions	Preset at an arbitrary position by using controls (50) and (51). 		

(65) MAG × 5 (CH-1)
Setting MAG × 5 to ON increases CH-1 sensitivity by 5 times with increased noise and a decline in the frequency bandwidth.
Set MAG × 5 to OFF unless super-high sensitivity (1 mV/div) is required. The MAG × 5 ON LED is on when MAG × 5 is set to ON.

(66) MAG × 5 (CH-2)
Setting MAG × 5 to ON increases CH-2 sensitivity by 5 times with an increased noise and a decline in frequency bandwidth.
Set MAG × 5 to OFF unless super-high sensitivity (1 mV/div) is required. The MAG × 5 ON LED is on when MAG × 5 is set to ON.

(67) GND TEST (CH-1)
CH-1 is set to GND when this key is pressed and held; returns to original state when the key is released.
This function is convenient for checking the GND position since it can be used in any operating mode.

(68) GND TEST (CH-2)
CH-2 is set to GND when this key is pressed and held.
Similar to GND TEST (67) in all other respects.

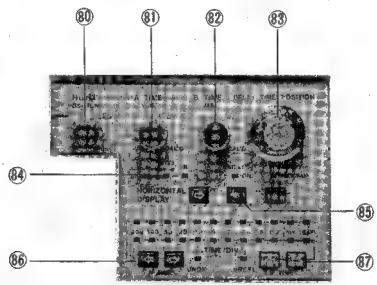
(69) CH-1 or [X] IN
Input connector for the CH-1 vertical amplifier and X-axis (horizontal axis) during X-Y operation. Ensure that the maximum permissible input voltage of 200V (ACp-p + DC) is not exceeded.

(70) CH-2 or [Y] IN
Input connector for the CH-2 vertical amplifier and Y-axis (horizontal axis) during X-Y operation. Ensure that the maximum permissible input voltage of 200V (ACp-p + DC) is not exceeded.

(71) ⊥ Ground pin
Observation signal ground Terminal

(72) LED OFF
Switch used to turn off LED's except the TRIG'D and DELAY TIME POSITION. The red LED OFF lamp goes on when the LEDs are off.

5.6 Horizontal Amplifier, (80) ~ (87)



Note: Controls marked with [PTP] (pull to program) are programmable only when pulled. When pushed, these controls are controlled by data stored in memory.

(80) [X] ⟷ (Horizontal position control)
Turn this control clockwise to move the waveform on display to the right, counter-clockwise to move it to the left.

(81) A TIME VARIABLE (Timebase adjuster)
Adjusts continuously between ranges of TIME/DIV (57).
Usually, keep it turned fully clockwise until a click sounds for time measurement.

(82) B TIME VARIABLE (Timebase adjuster)
Same as (81).

(83) DELAY TIME POSITION (10-Turn dial)
Sets the start point (delay time) for B TIME (delayed sweep) as opposed to A TIME (main sweep)
When 100 is set to other than B START AFTER TRIGGER, however, the sweep jumps to the next trigger point without the delay time being continuously controlled by this dial.

The DELAY TIME POSITION dial only functions when the PROGRAM LED below is on.

To turn on the PROGRAM LED and make the DELAY TIME POSITION (83) dial function, press the key below it.

(84) HORIZONTAL DISPLAY

A (Main sweep)

A TIME (main sweep: normal) is set when HORIZONTAL DISPLAY switch (84) is set to A.

INTEN BY B (Intensified Luminescent marking of the B sweep part)

Since the B sweep part is marked in luminescence, set DELAY TIME POSITION dial (83) and B TIME (Magnified sweep) switch (87).

B (Magnified sweep)

The B sweep part marked in luminescence is displayed throughout the CRT surface. Set the timebase using B TIME/DIV control (87).

(85) MAG × 10 (10 times magnifier)

Magnifies SWEEP SPEED by 10 times in the horizontal direction. Usually, leave this switch OFF to prevent loss of intensity.

In the X-Y mode, X-axis sensitivity is calibrated with MAG × 10 being off.

The yellow MAG × 10 ON LED goes on when MAG × 10 is selected.

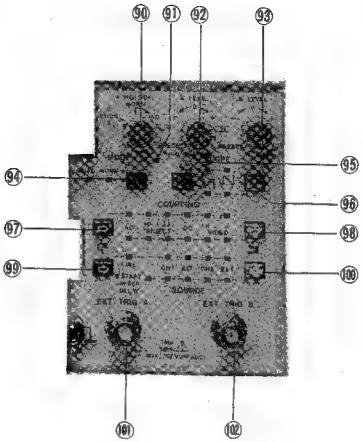
(86) A TIME/DIV (main sweep) timebase control

When HORIZONTAL DISPLAY (84) has been set to A, perform time measurement with this control. At time measurement, keep A TIME VARIABLE (81) fully turned clockwise until a click sounds. When HORIZONTAL DISPLAY (84) has been set to INTEN BY B, the period of time from the left edge of waveform A TIME to the left edge of enhanced intensity waveform B TIME is called a delay time. This time can also be measured with A TIME/DIV (86).

(87) B TIME/DIV (magnified sweep) timebase control

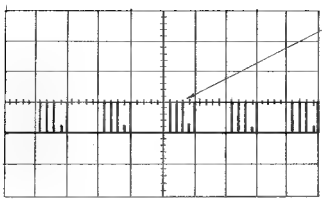
When HORIZONTAL DISPLAY (84) has been set to B, perform time measurement for the magnified waveform with this control. At time measurement, keep B TIME VARIABLE (82) fully turned clockwise until a click sounds.

5.7 Trigger Block, (90) ~ (102)

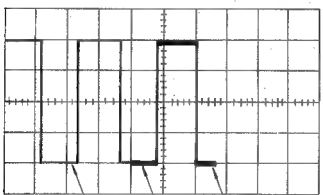


Note: Controls marked with PTP are programmable only when pulled. When pushed, these controls are controlled by data stored in memory.

(90) A HOLD OFF (Variable hold-off control)
Adjusts hold-off time for A time (main sweep). Turning the control in the INC direction ↻ increases hold-off time, gradually darkening the waveform on display.
Normally, keep this control turned to the NORM position (with the white mark coming right above) until a click sounds.
For synchronizing with a pulse train like that shown below, turn this control to a suitable position to stabilize the waveform on display. (If the waveform were stabilized by turning A VARIABLE (81), A sweep time (86) would be set to UNCAL. (uncalibration), thus disabling time measurement.)

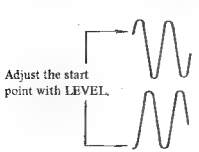


B ENDS A is set when this control is fully turned clockwise to the lock position.
The B ENDS A function suppresses unwanted A sweeps upon completion of an A sweep to keep the delayed, brightness of magnified sweep on display as intense as possible.

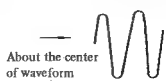


(91) TRIG'D lamp
Indicates that A TIME (main sweep) is being correctly triggered by a synchronizing signal.

(92) LEVEL −(0)+, PRESET (Synchronizing point control)
Sets the A TIME (main sweep) at a suitable start point. The synchronous sweep stops when this setting deviates from the changed portion of the waveform being observed.
If AUTO/NORM (94) has been set to NORM, the waveform on display is cleared at the same time. AUTO (94) allows continued display of the waveform.



PRESET LEVEL (control fully turned counterclockwise until a click sounds) has been preset at about the center of the waveforms.



(93) LEVEL − 0 +, PRESET

Sets the trigger sweep at a suitable start point, like LEVEL (92) for the A sweep, when synchronizing the A sweep with SOURCE (100) being set at other than B START AFTER DELAY.

The B sweep stops when the setting deviates from the changed portion of the waveform observed.

(94) AUTO/NORM

NORM: Generates synchronizing pulses from the synchronizing signal applied and starts and sweep concurrently with the lighting of TRIG'D lamp (91).

The waveform on display is cleared when TRIG'D lamp (91) is off.

AUTO: The A sweep free-runs automatically to display a horizontal trace when TRIG'D lamp (94) is off (for example, when no input is received).

This position is useful for checking the zero position of an input signal. A synchronous sweep starts automatically and concurrently when the TRIG'D lamp lights.

(95) + / − (A sweep synchronizing slope, TV signal polarity)

Set to (+) to perform a trigger sweep on the positive slope of the waveform on display, and set to (−) to perform a trigger sweep on the negative slope of the waveform.

(96) + / − (B sweep synchronizing slope, TV signal polarity)

Although the B sweep is typically used in continuous delays with SOURCE (100) being set to START AFTER DELAY, and need may arise to synchronize the B sweep for such purposes as displaying a waveform with minimized jitter. With SOURCE (100) being set to other than START AFTER DELAY, the B sweep synchronizing slope can be set in the same way as (95).

(97) COUPLING (Synchronous coupling selection)

Select the signal components so as to achieve a more stabilized synchronization in leading A sweep synchronizing signals to the synchronizing circuit.

AC (AC coupling): Leads the signal components in the entire bandwidth above 10 Hz to the synchronizing circuit. Normally used at this position.

HF REJ (High-frequency rejection): Leads signal components at about 10Hz~50kHz to the synchronizing circuit. Stable synchronization is achieved because harmonic components, such as noises and oscillations, are removed.

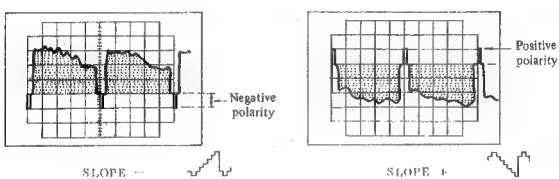
LF REJ (Low-frequency rejection): Leads signal components in the entire bandwidth above 500 Hz to the synchronizing circuit. Stable synchronization is achieved because low-frequency components, such as hums and ripples, are removed.

DC (DC coupling): Passes the entire bandwidth including DC. Use this position to synchronize very low frequencies on the order of several cycles or below. Set AUTO/NORM (94) to NORM at this time.

TV-H (Horizontal synchronization):
TV-V (Vertical synchronization): } TV video signal synchronous separation.

In this mode, a synchronous separation circuit similar to one used by TV sets is activated by TV/VTR composite video signals to yield stable displays.
SLOPE (95) must be selected to suit the polarity of the video signal as shown below.

Video signal synchronizing pulse polarity and slope selection



(98) COUPLING (Synchronous coupling selection)
Select the signal components so as to achieve more stabilized synchronization in leading B sweep synchronizing signals to the synchronizing circuit.

AC (AC coupling): Leads the signal components in the entire bandwidth above 10 Hz to the synchronizing circuit. It is normally used at this position.

HF REJ (High-frequency rejection): Leads signal components at about 10Hz~50kHz to the synchronizing circuit. Stable synchronization is achieved because harmonic components, such as noises and parasitic oscillations, are removed.

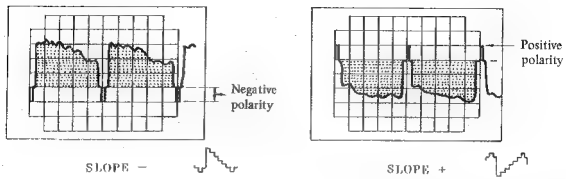
LF REJ (Low-frequency rejection): Leads signal components in the entire bandwidth above 500 Hz to the synchronizing circuit. Stable synchronization is achieved because low-frequency components, such as hums and ripples, are removed.

DC (DC coupling): Passes the entire bandwidth including DC. Use this position to synchronize very low frequencies on the order of several cycles or below. Set AUTO/NORM (94) to NORM at this time.

TV-H (Horizontal synchronization):
TV-V (Vertical synchronization): } TV video signal sync separation

In this mode, a sync. separation circuit similar to the one used in a TV set is activated by TV/VTR composite video signals to yield stable displays.
SLOPE (96) must be selected to suit the polarity of the video signal as shown below.

Video signal synchronizing pulse polarity and slope selection



B TRIG'D TV-H synchronization: Use this function to observe vertical interval test singals (VITS) or vertical interval reference signals (VIR), which are contained for a 1H period during a vertical sweep period of composite video signals, or for control codes during video disk picture searches.

(99) SOURCE (A Synchronizing signal source selection)

Select the signal source for synchronizing the A sweep. Normally, ALT, CH-1, and CH-2 are selected. For the power frequency signal waveform, select LINE synchronization. ALT ~ LINE synchronization is called internal synchronization.

LINE (Power supply) trigger: Extracts the signal source from the commercial primary supply and leads it to the synchronizing circuit. Used for synchronizing low ripples in the rectifying power supply.

CH-1 Trigger: Extracts the synchronizing signal from CH-1 vertical axis signals as the A sweep synchronizing signal source and leads it to the synchronizing circuit.

ALT (Dual trace) trigger: Extracts vertical axis input CH-1 and CH-2 signals alternately and leads them to the synchronizing circuit.
This synchronization mode is used for synchronizing two signals having different frequencies and phases on display. Whenever the ALT trigger mode is used, V MODE (56) must able be set to ALT (dual trace).
Also, if the ALT trigger mode is selected with V MODE (56) being set to other than CHOP, the respective synchronizing signals can be selected. At the ADD setting, however, the A sweep is synchronized with the CH-2 signal.

CH-2 trigger: Extracts the synchronizing signal from CH-2 vertical axis signals and leads it to the synchronizing circuit.

EXT trigger
(External synchronization): Used to supply a synchronizing signal externally.

(100) SOURCE (B Synchronizing signal source selection)

Selects the signal source for synchronizing the B sweep. Normally, ALT, CH-1, and CH-2 are selected. For the power frequency signal waveform, select LINE synchronization. ALT ~ LINE synchronization is called internal synchronization.

CH-1 trigger: Extracts the synchronizing signal from CH-1 vertical axis signals and leads it to the synchronizing circuit.

ALT (Dual trace) trigger: Extracts vertical axis input CH-1 and CH-2 signals alternately as the B sweep synchronizing signal source and leads them to the synchronizing circuit. This synchronization mode is used for synchronizing two signals having different freqencies and phases on display.
Whenever the ALT trigger mode is used, V MODE (56) must also be set to ALT (dual trace).
Also, if the ALT trigger mode is selected with V MODE (56) being set to other than CHOP, the respective synchronizing signals can be selected. At the ADD setting, however, the A sweep is synchronized with the CH-2 signal.

CH-2 trigger: Extracts the synchronizing signal from CH-2 vertical axis signals and leads it to the synchronizing circuit.

EXT trigger
(External synchronization): Used to supply a synchronizing signal externally.

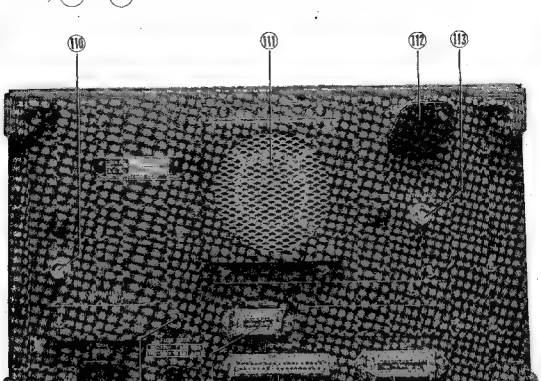
(101) EXT TRIG IN (A sweep external synchronization) input terminal

Input terminal is used to apply an external synchronizing signal to A TIME (main sweep). Ensure that the maximum permissible input voltage of 200V (ACp-p + DC) is not exceeded.

(102) EXT TRIG IN (B sweep external synchronization input terminal.

Input terminal is used to apply an external synchronizing signal to B TIME (main sweep). Ensure that the maximum permissible input voltage of 200V (ACp-p + DC) is not exceeded.

5.8 Rear Panel, (110) ~ (119)



(110) CH-1 OUTPUT (CH-1 signal output terminal)
Signals applied to CH-1 are constantly transferred to this BNC terminal from the oscilloscope vertical axis CH-1 preamp through a buffer amp.
Since an output of about 100mVp-p per division of screen amplitude is yielded at 50 ohm termination, suitable signals can be automatically obtained by connecting a frequency counter to the LBO-5880. In this setup, the oscilloscope can function as a high-sensitivity counter.

(111) BLOWER air outlet
Allows dispersion of internally generated heat. Position it in a well ventilated place.

(112) Regulator IC mounting cover
Contains a regulator IC for the +5 V internal power supply.

(113) INTEN MOD (Z-axis input terminal)
A signal is applied to this terminal for intensity modulation of the waveform on display. Blanking can be performed by applying a positive TTL level signal.

(114) Power cord, AC inlet
Observe the specified input voltage rating.

(115) ⏚ (Ground terminal)

(116) FUSE (Fuse)
The fuse can be removed together with the cap by turning the cap counterclockwise with a Phillips screwdriver. Observe the fuse type and rating.

(117) PRINTER

Connect an external printer to this connector for printing program data in PRINT mode (21).

The printer must be the one supporting a Centronix parallel interface. See 9.9 for further details.

(118) I/O PORT

Use it to execute LOAD, SAVE, and REMOTE operation (21) and use data transfer from the personal computor through the I/O interface card LC-2330.

(119) I/O BUS

Connect a probe selector or GP-IB interface adaptor (still designing) to this bus. It can also be used for EXT control purposes.

6. OPERATING NOTES

6.1 Observe Supply Voltage Rating

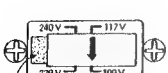
Use a supply voltage within ±10% of the specified rating. Correct performance is unpredictable when the oscilloscope is used at −10% or less of the specified voltage rating. Also, the power supply unit could be burned out if the oscilloscope were used at +10% or above of the specified voltage rating.

Check the voltage ranges and fuse ratings indicated on the rear panel of the oscilloscope.

Specified voltage	Operating voltage range (±10%)	Fuse rating
100V	90 ~ 110V	1.6A TIME LAG
117V	110 ~ 130V	
200V	180 ~ 220V	0.8A TIME LAG
220V	200 ~ 240V	
240V	220 ~ 260V	

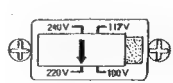
Voltage setting method

The oscilloscope can be set to a specified voltage by altering the position and direction of the voltage change plug and the socket blind plate, which is used to cover the hole on the socket that is not concealed when the plug is inserted into the socket.

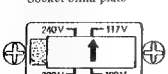


When specified voltage is 100V

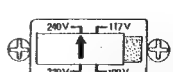
Socket blind plate



When specified voltage is 220V



When specified voltage is 117V



When specified voltage is 240V

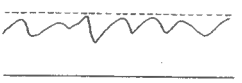
6.2 Do Not Apply Excessive Input Voltage ⚠

There are prescribed limits on the signal voltages that can be applied to the individual input and probe terminal. Excessive voltage input could cause damage to the circuit components.

Vertical input INPUT (69), (70)	MAX 200V (ACp-p + DC)
External synchronizing signal input TRIG IN (101), (102)	MAX 200V (ACp-p + DC)
Probe input	MAX 600V (ACp-p + DC)

*Probes are options.

The maximum 200V (ACp-p + DC) refers to the absolute peak value of 200V as shown below.



6.3 Do Not Use in a Strong Magnetic Field

If the oscilloscope were used in a strong magnetic field, the waveform on display might oscillate or the horizontal trace might be inclined to a large extent. Be careful especially when using the oscilloscope side by side with a device using a transformer with large power consumption.

6.4 Avoid Using in a High Temperature, Damp Place

The oscilloscope should be used in the temperature range of 0°C to 40°C and in the humidity range of 10 ~ 90% relative humidity. Adverse ambient conditions could lessen the useful life of the oscilloscope.

6.5 Notes on CRT

Though the CRT uses burn-resistant phosphorus, continued drawing of spots or luminescent lines at increased intensity levels could burn the phosphorous surface. Take care not to increase intensity to an unnecessary level during waveform observation. When leaving the oscilloscope powered on, reduce the intensity and blur the focus.

6.6 Turn Power Switch Off Before Connecting Bus Cables

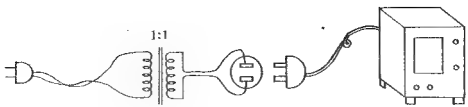
Turn power switch (11) off before connecting a bus cable to PRINTER (117), I/O PORT (118), or I/O BUS (119); otherwise, a malfunction may result.

6.7 Notes on Connecting to a Transformer-less Device

Some transformer-less devices have a primary power line connected to their chassis.

Provide adequate protection against electrical shock hazards in connecting the oscilloscope to such a device, particularly when grounding the chassis for measuring internal C-MOS circuits for example. The interiors of the oscilloscope or the chassis of the device being testing could be shorted or burned out in some cases.

The best protection is by using a 1:1 isolation transformer as shown next.



In grounding the system, connect the ground cable to the ground pin on the LBO-5880.

6.8 Notes on Shutdown

Programs created by using the controls mentioned in 5.4 are written to internal memory (RAM). As the power to the main unit (LBO-5880) is turned on, the built-in backup battery is charged to protect programs in RAM in the event of power failure.

The backup battery is fully charged through the energization of the main unit for about two days (about 25 hours or longer).

The battery will not be overcharged even though the main unit is energized further.

- Memory protection period
  The memory contents are protected even if the main unit is powered off for one month after the backup battery is fully charged.
- Memory writing
  After the main unit has been powered off for one month or longer, power it on for two days (25 hours or longer) before writing programs to memory. Otherwise, programs written to memory might be lost overnight.

6.9 Notes on Memory Write Protection

The internal memory of this oscilloscope can be write-protected to prevent inadvertent deletion of stored programs.

The write protection status is displayed on LEDs (30) and (31), which usually display a program address, for 0.5 second each time the power to the oscilloscope is turned on.

: Write protection on (Protect)

: Write protection off (Unprotect)

See 9.16 for the write protection procedures.

If writing to memory is attempted while write protection is on, error 41 will be displayed blinking along with an audible alarm to notify the operator of the write protection status.

7. PROBE TYPES AND SELECTION (Probes are options.)

Standard low-capacitance probes can be used with the LBO-5880 to minimize the possible effects they may have on the device being tested. Generally, 1/10 and 10 MΩ probes are used with oscilloscopes. In addition, several probe types are optionally available for selection.

(a) Low-capacitance probe
Usually, this is a 1/10 attenuation probe with an input capacitance of 10 ~ 25 pF and an input resistance of 10 MΩ.

(b) Direct probe
The direct probe has a combined input capacitance of 100 ~ 200 pF, including the direct addition of the capacitance of the cable used (1.5C-2V, 1 m, about 70 pF).
With a convenient probe-tip function, however, the direct probe allows the oscilloscope to function as a high-sensitivity oscilloscope in the low-frequency regions of power supply circuits, etc.

LP-16BX type:
1/1 and 1/10 switching probe
DC ~ 40 MHz (1/10)
DC ~ 5 MHz (1/1)
600V, 10MΩ, 25 pF or less
BNC plug

(c) High-impedance probe
Used for measuring FETs and C-MOS circuits.
The 1/100 attenuation type has an input capacitance of 5-10 pF, with an input resistance of 100 MΩ. The 1/100 Attenuation allows the 2 V/div range to be used as 200 V/div.

LP-17AX type:
1/10 and 1/100 switching type
DC ~ 40 MHz (1/10), 600V
DC ~ 20 MHz (1/100), 1500V
BNC plug

(d) High-voltage probe
Used for measuring horizontal output pulses as in high-voltage circuits in TV sets. Maximum input 2000 V(ACp-p + DC), input resistance 100 MΩ, 1/100 attenuation.

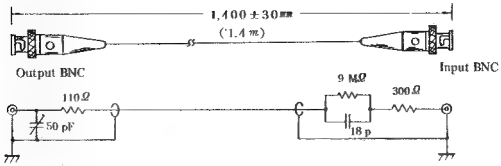
LP-012X type:
1/100 high-voltage probe
DC ~ 20MHz
100 MΩ, 2000V
BNC plug

(e) Wideband probe
Used for measuring high-frequency circuits.
Generally, a cable using a special resistance wire as the core is used as the wideband probe. Its 50 ~ 100 MHz bandwidth fully allows for pulse characteristics.

LP-100X type:
1/10 wideband probe
DC ~ 100 MHz
10 MΩ, 12 pF, 600V
BNC plug

(f) Device BNC-BNC probe
Convenient for using the oscilloscope in direct connection with a board checker, like a program oscilloscope system.

LP-010 type:
1/10 BNC-BNC probe (device connection)
DC ~ 30 MHz
500V, 10 MΩ



(g) Detection probe

Used for observing high-frequency (50 ~ 100 MHz) modulated enveloped waveforms.

LP-7X type: Frequency 150 kHz ~ 100 MHz
Maximum input voltage 5 Vrms
(Low-capacitance probe 15 MHz, 1/10)

8. BASIC OPERATIONS

8.1 Displaying a Horizontal Trace, ABORT + BEGIN

When using the oscilloscope for the first time, display a horizontal trace by setting its controls as specified below.

	Name	Controls
(11)	POWER ▮ OFF/ ▬ ON	POWER OFF ▮
(16)	FUSE	1.25A for 90~132V, 0.63A time-lag type for 180~264V
(14)	Inlet	Insert the accessory cable into the inlet after checking the power rating.
(21)	OPERATING MODE	Set to the PROG mode.
	Controls with pull switch	Push all. Set INTEN (16) at the center position.

(16) (50) (51) (52) (53) (54) (55) (80) (81) (82) (83) (90) (92) (93)

After the above settings are complete, set POWER ON (11). When BUSY LED (29) is off, press BEGIN key (36) while holding down ABORT key (27). Then, a sample program is called to display a horizontal trace. Push both button same time, ABORT + BEGIN

(Reference) The following modes are set:

```
===== L3D-5BBB  PROGRAM LIST =====

------ SCOPE CONTROL ------

V. MODE                          ALT

CH-1 V. ATT                      2 V/DIV
CH-1 VAR.                        UNCAL
CH-1 CPL.                        AC
CH-1 POL.                        NORMAL
CH-1 MAG                         X1
CH-1 CLAMP                       +

CH-2 V. ATT                      2 V/DIV
CH-2 VAR.                        UNCAL
CH-2 CPL.                        AC
CH-2 POL.                        NORMAL
CH-2 MAG                         X1
CH-2 CLAMP                       +

H. DISPLAY                       A
TRIG. MODE                       AUTO
H. MAG                           X1

A SWEEP TIME                     1m sec/DIV
A VARIABLE                       CAL'D
A TRIG. CPL.                     AC
A TRIG. MODE                     CH-1
A TRIG. POL.                     +

B SWEEP TIME                     100u sec/DIV
B VARIABLE                       CAL'D
B TRIG. CPL.                     AC
B TRIG. MODE                     CH-1
B TRIG. POL.                     +

------ VARIABLE CONTROL ------

CH-1 V POSITION                  7FF
CH-2 V POSITION                  7FF
H POSITION                       7FF
LOWER CURSOR POSITION            7FF
UPPER CURSOR POSITION            7FF
CH-1 GAIN VARIABLE               7FF
CH-2 GAIN VARIABLE               7FF
A TIME VARIABLE                  7FF
B TIME VARIABLE                  7FF
A TRIGGER LEVEL                  7FF
B TRIGGER LEVEL                  7FF
A HOLD OFF VARIABLE              7FF
INTEN VARIABLE                   7FF
DELAY TIME POSITION              7FF

---- LEADER ----
```

9. GENERAL OPERATIONS

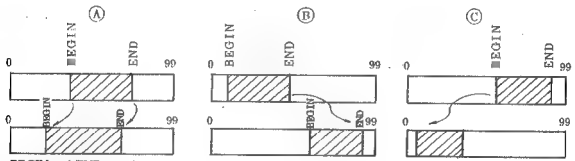
9.1 Setting BEGIN and END Addresses

The LBO-5880 has memory addresses 0 ~ 99, in the range of which the BEGIN and END addresses can be set to eliminate the need to read or write the contents of unnecessary memory addresses.

Also, processing programs can be stored in blocks and BEGIN and END addresses can be set for each block to fully utilize memory.

The BEGIN and END addresses, once set, are protected from deletion in the event of power failure.

(1) Set OPERATING MODE (21) to SET.
(2) Check the current BEGIN address by pressing (36).
(3) Check the current END address by pressing (37).
(4) The BEGIN and END addresses can be altered in the four possible ways: (A), (B), and (C). (A) is not a problem, but (B) and (C) call for special consideration because BEGIN ≧ END is assumed an error.



BEGIN and END may be altered in any order, because the relation BEGIN < END is met anyway.

END is altered first.

BEGIN is altered first.

[Case Ⓑ]

(5) First, press INC (32), DEC (33), INC 10 (34), and DEC 10 (35) so as to display the desired END address.
(6) When the desired END address is displayed, press END key (25) to set it.
(7) As in (5), press INC (32), DEC (33), INC 10 (34), and DEC 10 (35) so as to display the desired BEGIN address.
(8) When the desired BEGIN address is displayed, press BEGIN key (26) to set it.
(9) The BEGIN and END addresses have now been set. Press BEGIN (36) and END (37) to review them.

[Case Ⓒ]

(5) First, press INC (32), DEC (33), INC 10 (34), and DEC 10 (35) so as to display the desired BEGIN address.
(6) When the desired BEGIN address is displayed, press BEGIN key (26) to set it.
(7) As in (5), press INC (32), DEC (33), INC 10 (34), and DEC 10 (35) so as to display the desired END address.
(8) When the desired END address is displayed, press END key (25) to set it.
(9) The BEGIN and END addresses have now been set. Press BEGIN (36) and END (37) to review them.

9.2 Writing To Memory

(1) Set OPERATING MODE (21) to SET.
Set BEGIN and END addresses as instructed in 9.1. (If BEGIN = 0 and END = 99 are set, programs can be written to any addresses.
However, to prevent alteration of programs due to inadvertent Activation of WRITE key (24) , it is recommended that the BEGIN and END addresses be limited within the address range to be rewritten.

(2) Press INC (32) , DEC (33) , INC 10 (34) , and DEC 10 (35) to display the address to be written.

(3) If the vertical, horizontal, and TRIG mode LEDs are off, press LED OFF key (72) to turn on the LEDs. Then, the red LED OFF LED goes off.

(4) Set OPERATING MODE (21) to PROG.
As with a regular oscilloscope, turn the INTEN, and vertical and horizontal amplifier key switches and controls to display a waveform while viewing the CRT screen.
To alter the INTEN and POS settings, pull the controls before turning them. Press the key below to DELAY TIME POSITION control to turn on the yellow PROGRAM LED before turning it.

(5) When the settings are complete, press WRITE key (24) and the program is written to memory an audible alarm (*). The address is then incremented by one.
Note: The address written to memory is the address on LED display before write.

(6) To continue programming, repeat from (4) downward.

*If ERROR #41 (4.1) is displayed, it indicates that memory write protection is on. See 9.16.2 for instructions on how to reset write protection.

9.3 Editing Programs

When it is necessary to edit a program that has been stored in memory, set OPERATING MODE (21) to RUN PROG and call the address requiring alterations by pressing keys (32) ~ (35) . The addressed program data is then transferred to panel operation memory.

9.3.1 Changing only control settings, such as POSITION and VARIABLE

(1) Pull only the control that requires reprogramming, leaving all other controls pushed. Usually set DELAY TIME POSITION (83) so the PROGRAM LED is off; turn on the PROGRAM LED only when it is to be reset.

(2) Set OPERATING MODE (22) to CHANGE VAR's. (In this mode, only the control to be reset is operative, and all other switch functions, including VERTICAL MODE (56) , are suppressed.)

(3) Alter the control setting, moving the waveform by turning the control while viewing the CRT screen.

(4) When the alteration of the control setting is complete, press WRITE key (24) to write the new setting to memory an audible alarm. (The address is not incremented.)

(5) To continue with further alterations, set OPERATING MODE (22) to RUN PROG (even when it has been set to CHANGE VAR's and all controls are pushed) and call the next address by pressing keys (32) ~ (35) . Transfer the program data to panel operation memory before performing steps (1) through (4).

9.3.2 Altering modes other than controls

(1) Set OPERATING MODE (22) to RUN PROG.

(2) Call the address to be altered by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).
The addressed program data is automatically trasferred to panel operation memory.

(3) Set OPERATING MODE (22) to PROG.

(4) Pull only the control that requires reprogramming, leaving all other controls pushed. Usually set DELAY TIME POSITION (83) so the PROGRAM LED is off; turn on the PROGRAM LED only when it is to be reset.

(5) Alter the oscilloscope mode by turning the appropriate key or control while viewing the screen.

(6) When the alteration of the mode setting is complete, press WRITE key (24) to write the new mode to memory along with an audible alarm. The address is incremented automatically.

(7) To continue with further alterations, repeat steps (1) through (6).
If all controls have been pushed and the PROGRAM LED below DELAY TIME POSITION (83) is off, OPERATING MODE (22) may be set to CHANGE VAR's before steps (2) through (6) can be performed.

9.4 Editing Program Addresses

This section explains how to perform editing, including alteration, addition, and deletion, of addresses to alter the sequence of program execution.

9.4.1 DELETE (Deletion)

This function deletes the program data at the current address, moving all subsequent program data forward until the END address is moved forward by one address.

(1) Consider deleting an address. For this purpose, first set the BEGIN and END addresses in where the address to delete is located.

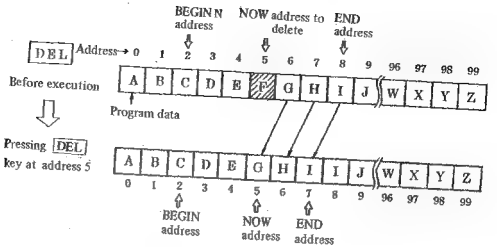
(2) Set OPERATION MODE (22) to PROG.

(3) Set the address to delete (5, for example) by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).

(4) When the address to delete is reached, press DELETE key (26).
The program data at the current address is deleted along with an audible alarm, and all the following program data till the END address is moved forward by one address. The END address is then decremented.

NOTE: The DELETE function cannot be used at the END address to prevent shifting of data other than that between the BEGIN and END addresses.

The following shows the case in which program data is deleted at address 5. (Data at address 8 and later addresses is not edited.)



9.4.2 INSERT (Insertion)

This function allows insertion of new program data at the current address by moving all subsequent addresses backward until the END address is moved by one address.

(1) Set OPERATING MODE (22) to SET and set the insertion address range.
Note: A program insertion occurs at the END address +1; in other words, the program is written up to this point.

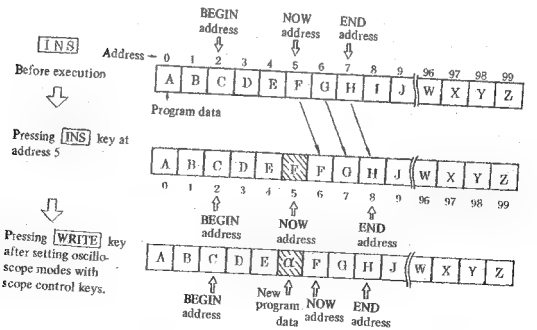
(2) Set OPERATING MODE (22) to PROG.

(3) Display the address to insert by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).

(4) When the address to be inserted is displayed, press INSERT key (25). An audible alarm sounds and the program data up to the END address is moved backward by one address. The END address is incremented by one.

(5) Then, press WRITE key (24) after setting the oscilloscope mode keys and controls while viewing the CRT screen. New program data will be inserted at the current address.

The following shows the case in which program data is inserted at address 5.

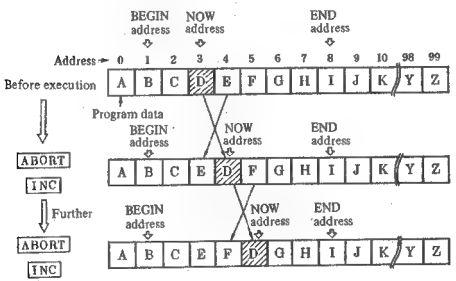


9.4.3 EXCHANGE INC (Exchanging with the next address)

This function exchanges program data at the current address with that at the next address. By repeating this operation, program data can be exchanged with separated addresses.

(1) Set OPERATING MODE (22) to PROG.
(2) Display the address to exchange by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).
(3) When the address to exchange is displayed, press INC (32) while holding down ABORT key (27). The current is then incremented by one.
Note: Be sure not to press INC (32) first.
(4) To continue with further exchanging, repeat steps (2) and (3).

The following shows the case in which EXCHANGE INC is executed at address 3 two times in succession.

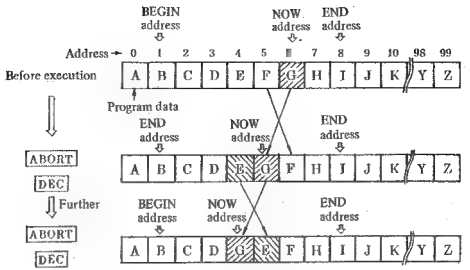


9.4.4 EXCHANGE DEC (Exchanging with the previous address)

This function exchanges program data at the current address with that at the previous address. By repeating this operation, program data can be exchanged with separated addresses.

(1) Set OPERATING MODE (22) to PROG.
(2) Display the address to exchange by pressing INC (32), DEC (33), DEC 10 (34), and DEC 10 (35).
(3) When the address to exchange is displayed, press DEC (33) while holding down ABORT key (27). The current address is decremented by one.
Note: Be sure to press DEC (33) first.
(4) To continue with further exchanging, repeat steps (2) and (3).

The following shows the case in which EXCHANGE DEC is executed at address 6 two times in succession.



9.5 Manual Operations

When OPERATING MODE switch (21) is set to MANUAL, the memory control keys WRITE (24), ABORT (27), INC (32), and END (37) are disabled and 8. (BUSY DOT (29) only lit) is displayed on LEDs (30) and (31).

The stored program is protected from possible alteration due to inadvertent activation of WRITE key (24) because all memory control keys are suppressed.

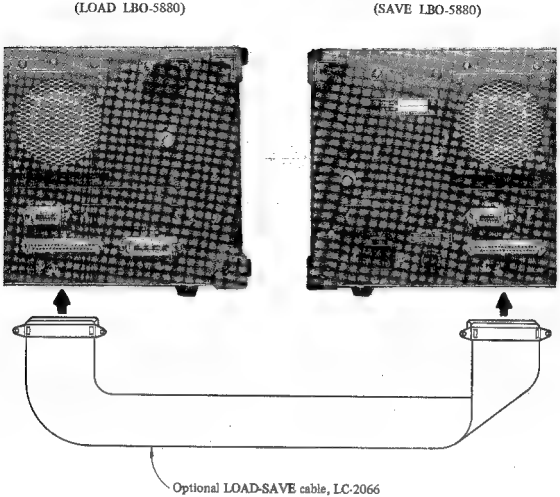
The MANUAL mode is used to operate the oscilloscope as a regular scope without reading or writing programs.

Note: No program address is displayed on LEDs (30) and (31) in the MANUAL mode because no memory functions are used.

9.6 Program Transfer (SAVE/LOAD)

The program transfer function transfers programs from a preprogrammed LBO-5880 to another LBO-5880. The entire program from address 0 to address 99 may be transferred, or only program data at a particular address may be transferred to another address.

The cabling setup necessary to perform the SAVE operation is shown below.



Connect the cable to I/O PORT (18) on both the LOAD and SAVE oscilloscopes.

9.6.1 Transferring the entire program from address 0 to address 99

(1) Set OPERATING MODE (22) to SET on both the LOAD and SAVE oscilloscopes, and set the BEGIN address to 0 and the END address to 99. For more detailed instructions, see "Setting BEGIN and END Addresses."
(2) Set OPERATING MODE switch (22) for the SAVE LBO-5880 to SAVE.
(3) Set OPERATING MODE switch (22) for the LOAD LBO-5880 to LOAD.
(4) Press BEGIN/END key (25) on the LOAD LBO-5880.

L b. is displayed on LEDs (28) ~ (31) . (LOAD B mode: Begin ~ End)

(5) Press BEGIN/END key (25) on the SAVE LBO-5880.

5b. is displayed on LEDs (28) ~ (31) . (SAVE B mode: Begin ~ End)

(6) As the transfer is started, the address being transferred is displayed on LEDs (28) ~ (31) on both the LOAD and SAVE oscilloscopes.

2 7. (Address 27 in transfer)

(7) When the transfer upto the ADDRESS 99 is ended, (29) BUSY LED turns out and the LOAD and SAVE end.

9.6.2 Transferring an address range

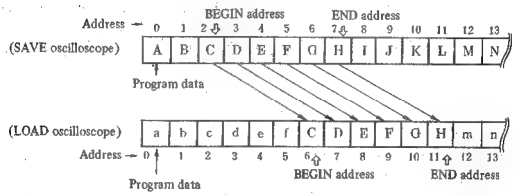
(1) Set OPERATING MODE switch (22) to SET on both the LOAD and SAVE oscilloscopes, and set the BEGIN and END addresses to the address range to be transferred.
Perform steps (2) through (6) in 9.6.1

(7) When data transfer is finished to the END address, BUSY LED (29) goes off, indicating the completion of LOAD/SAVE.

9.6.3 Transferring an address range with an offset

(1) Set OPERATING MODE switch (22) on the LOAD oscilloscope to SET, and set the BEGIN and END address range to LOAD.
Next, set OPERATING MODE switch (22) on the SAVE oscilloscope to SET, and set the BEGIN and END address range to save. Perform steps (2) through (7) in 9.6.2.

Shown below is a sample execution of a LOAD/SAVE operation, in which
SAVE oscilloscope: BEGIN = 2, END = 7
LOAD oscilloscope: BEGIN = 6, END = 11



9.6.4 Transferring only one address

(1) Set OPERATING MODE switch (22) on the LOAD oscilloscope to SET, and set the BEGIN and END address range that may be loaded. (Usually, set BEGIN = 00 and END = 99.)

(2) Set OPERATING MODE switch (22) on the SAVE oscilloscope to SET, and set the BEGIN and END address range that may be saved. (Usually, set BEGIN = 00 and END = 99.)

(3) Set OPERATING MODE switch (22) on the SAVE oscilloscope to SAVE.

(4) Set OPERATING MODE switch (22) on the LOAD oscilloscope to LOAD.

(5) Display the SAVE address by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).

(6) Display the LOAD address by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).

(7) Press SINGLE key (26) on the LOAD oscilloscope.

LA. is displayed on LEDs (28) ~ (31). (LOAD A mode: Single)

(8) Press SINGLE key (26) on the SAVE oscilloscope.
SA. is displayed on LEDs (28) ~ (31). (SAVE A mode: Single)

(9) When the transfer is completed, the LOAD and SAVE program addresses are incremented by one.

(10) To continue with further transfers, repeat steps (5) through (9) above.

9.7 Error Messages during Program Transfer

Invalid settings during program transfer are indicated by error messages displayed on LEDs (30) and (31).

Major error messages relating to program transfer are listed below. See Chapter 12 for the complete error message list.

20 The current oscilloscope is set in the SAVE mode, but the remote oscilloscope is not in the LOAD mode.

21 LOAD mode response from the remote oscilloscope was interrupted during SAVE (cable out of position).

22 The current oscilloscope is ready in the LOAD mode, but no data is transmitted from the remote oscilloscope.

23 Data transmission from the remote oscilloscope was interrupted during LOAD.

29 The END address was exceeded during LOAD.

30 The remote oscilloscope is also in the LOAD mode.

See Chapter 12 for more error messages.

9.8 LOAD/SAVE Data Format Description

9.8.1 Data format (General)

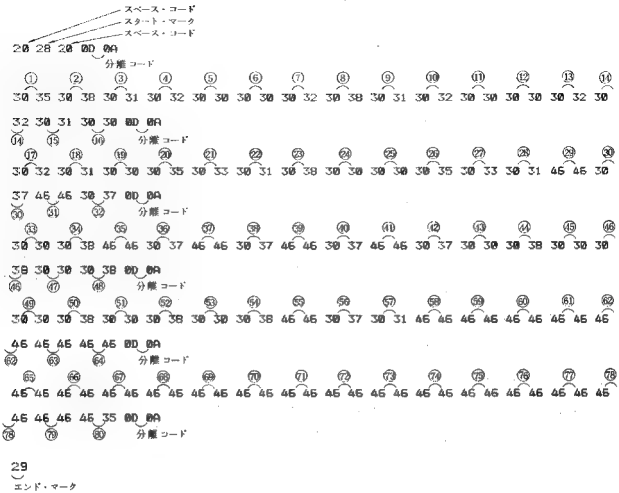
The format in which program data is loaded and saved is described below.

(Note: When program data is loaded or saved between LBO-5880's, internal data exchange occurs automatically, without user considerations about the data format. However, data format described here will be useful for loading and saving program data on the LBO-5880 during connection with a microcomputer.)

The LBO-5880 uses 80 bytes (8 bits × 10) to represent program data at each program address.

The data is converted into ASCII binary data headed by a start mark and terminated by an end mark.

A sample program involving a data transmission is shown on the next page.



In the above format, (1) through (80) denote 80-byte data, and circled figures indicate the byte order of the data.
All other data has been added for the purpose of executing LOAD and SAVE, and have no affect on the program data.
Shown below is a printout of the above ASCII binary data converted to binary.

```
(
05080102000002080102000002020100
02010005030108000000503 1FF07FF07
0008FF07FF07FF07FF0700030003000 8
0008000800080FF0701FFFFFFFFFFFFFF
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF5
```

Similarly, four-address program data is represented below.

```
(
05080102000002080102000002020100
02010005030108000005030lFF07FF07
0008FF07FF07FF07FF07000800080008
0008000800083FF8761FFFFFFFFFFFFF
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFF5

0608010201000208010201000201010C
02010105030808000005030l000BF006
03F08F022009F609FC0F0BF000F0FFF7
C8F8000097F2800900FFFFFFFFFFFFF
FFFFFFFFFFFFFFFFFFFFFFFFFFFFF5

04070102010001050101010001010100
0101010103000800000503000006F006
03F08F022009F609FC0F0CF000F0FFF7
C8F8000097F2800900FFFFFFFFFFFFF
FFFFFFFFFFFFFFFFFFFFFFFFFFFFF5

04070102010101050101010001010100
0101010103000800000503000006F006
03F08F022009F609FC0F0CF000F0FFF7
C8F8000097F2800900FFFFFFFFFFFFF
FFFFFFFFFFFFFFFFFFFFFFFFFFFFF5
)
```

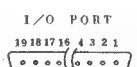
9.8.2 Signal line description

Because program data is exchanged at the timings shown below during LOAD and SAVE by the LBO-5880, program data can also be loaded and saved to and from a microcomputer if the LBO-5880 is interfaced to the microcomputer at these timings. Then, frequently exchanged programs could be stored on a microcomputer floppy disk and loaded into the LBO-5880 when needed.

The signal designations used during LOAD/SAVE are listed below.

(1) LSD7-D0: 8-bit data port is used during LOAD/SAVE. This is set in the input mode during LOAD, and in the output mode during SAVE.

(2) $\overline{\text{STROBE}}$: Synchronizing signal for transmitting program data to a remote oscilloscope. Generated by the SAVE oscilloscope.



(3) $\overline{\text{READY}}$: Signal to request program data transmission from a remote oscilloscope. Generated by the LOAD oscilloscope.

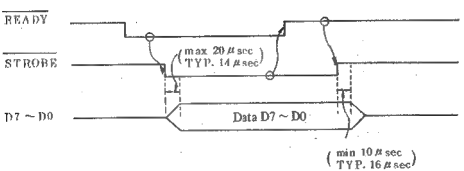
(4) $\overline{\text{PPIRES}}$: Reset signal synchronized with the LBO-5880 Power On Reset signal is used to reset an external device. It is normally high and becomes low when reset.

(5) *: Connected to the internal I/O port but not used during LOAD/SAVE.

(6) (NC): Not used

(7) GND: Signal ground level

PIN #		
1	LSD 7	(PAD 7)
2	LSD 5	(PAD 5)
3	LSD 3	(PAD 3)
4	LSD 1	(PAD 1)
5	GND	
6	GND	
7	GND	
8	GND	
9	GND	
10	GND	
11	GND	
12	GND	
13	*	(PBD 7)
14	*	(PBD 5)
15	*	(PBD 3)
16	*	(PBD 1)
17	$\overline{\text{PPIRES}}$	
18	(NC)	
19	GND	
20	LSD 6	(PAD 6)
21	LSD 4	(PAD 4)
22	LSD 2	(PAD 2)
23	LSD 1	(PAD 0)
24	$\overline{\text{STROBE}}$	(PCD 7)
25	*	(PCD 6)
26	*	(PCD 5)
27	*	(PCD 4)
28	*	(PCD 3)
29	*	(PCD 2)
30	*	(PCD 1)
31	$\overline{\text{READY}}$	(PCD 0)
32	*	(PBD 6)
33	*	(PBD 4)
34	*	(PBD 2)
35	*	(PBD 0)
36	(NC)	
37	GND	



Note: Data is underfined for a maximum period of 20 μsec after $\overline{\text{STROBE}}$ has become low. $\overline{\text{STROBE}}$ and $\overline{\text{READY}}$ effect signal changes upon verifying the level in O.

9.8.3 Data format (Detailed)

The LBO-5880 uses 80 bytes to represent the program data at each internal program address. The order in which mode data is written in memory is shown below. (Figures at left indicate the order in which mode data is written in memory.)

0	V-MODE
1	CH-1 V ATT
2	CH-1 V VARIABLE
3	CH-1 V COUPLE
4	CH-1 V INVERT
5	CH-1 V MAG
6	CH-1 V CLAMP
7	CH-2 V ATT
8	CH-2 V VARIABLE
9	CH-2 V COUPLE
10	CH-2 V INVERT
11	CH-2 V MAG
12	CH-2 V CLAMP
13	HORIZ. DISPLAY
14	TRIG. MODE
15	HORIZ. MAG X10
16	SWEEP TIME A
17	SWEEP TIME RANGE A
18	SWEEP TIME VARIABLE A
19	TRIG. COUPLE A
20	TRIG. SOURCE A
21	TRIG. SLOPE A
22	SWEEP TIME B
23	SWEEP TIME RANGE B
24	SWEEP TIME VARIABLE B
25	TRIG. COUPLE B
26	TRIG. SOURCE B
27	TRIG. SLOPE B
:	
28	A/D CH-1 POS LOW
29	A/D CH-1 POS HIGH
30	A/D CH-2 POS LOW
31	A/D CH-2 POS HIGH
32	A/D H POS LOW
33	A/D H POS HIGH
34	A/D UPPER CURSOR LOW
35	A/D UPPER CURSOR HIGH
36	A/D LOWER CURSOR LOW
37	A/D LOWER CURSOR HIGH
38	A/D CH-1 V VAR LOW
39	A/D CH-1 V VAR HIGH

40	A/D CH-2 V VAR LOW
41	A/D CH-2 V VAR HIGH
42	A/D A TIME VAR LOW
43	A/D A TIME VAR HIGH
44	A/D B TIME VAR LOW
45	A/D B TIME VAR HIGH
46	A/D A TRIG LEVEL LOW
47	A/D A TRIG LEVEL HIGH
48	A/D B TRIG LEVEL LOW
49	A/D B TRIG LEVEL HIGH
50	A/D A HOLD OFF VAR LOW
51	A/D A HOLD OFF VAR HIGH
52	A/D INTEN VAR LOW
53	A/D INTEN VAR HIGH
54	A/D DELAY TIME POS LOW
55	A/D DELAY TIME POS HIGH
:	
56	B ENDS A ON/OFF
57	(option)
58	(option)
59	(option)
:	
60	EXT. CONTROL #0
61	EXT. CONTROL #1
62	EXT. CONTROL #2
63	EXT. CONTROL #3
64	EXT. CONTROL #4
65	EXT. CONTROL #5
66	EXT. CONTROL #6
67	EXT. CONTROL #7
:	
68	(option)
69	(option)
70	(option)
71	(option)
72	(option)
73	(option)
74	(option)
75	(option)
76	(option)
77	(option)
78	(option)
79	(option)

```
(
05030102000002030102000002020100
02010005030103000005030 1FF07FF07
0003FF07FF07FF07FF0700030003000 3
0003000300030FF070 1FFFFFFFFFFFFF
FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF5
```

(Sample of one-address data)

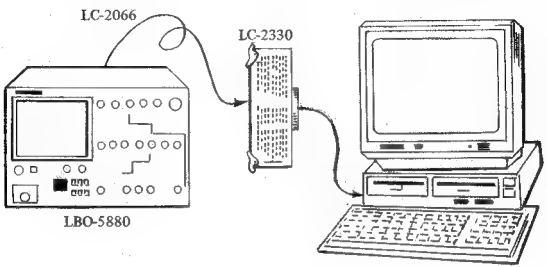
The relationships between the data written in memory and associated modes are shown below.
For example, the above shown sample data begins with 05. In the table below, ALT is given next to 05 under V-MODE. Hence, the oscilloscope has been set to operate in the ALT mode.

```
!
!=====  VERTICAL  ==========================================
!
!
!-----  V-MODE  ------------------------------------------
!
     00  !CH-2 & CURSOR
     01  !CH-1 & CURSOR
     02  !X-Y
     03  !ADD
     04  !CHOP
     05  !ALT
     06  !CH-2
     07  !CH-1

!
!-----  V ATT CH-1 & CH-2  -------------------------------
!
     01  ! 5 mV/DIV
     02  !10 mV/DIV
     03  !20 mV/DIV
     04  !50 mV/DIV
     05  !0.1 V/DIV
     06  !0.2 V/DIV
     07  !0.5 V/DIV
     08  !1 V/DIV
     09  !2 V/DIV

!
!-----  V VARIABLE CH-1 & CH-2  --------------------------

     00  !CAL'D
     01  !UNCAL

!
!-----  V COUPLING CH-1 & CH-2  --------------------------
!
     00  !DC
     01  !GND
     02  !AC

!
!-----  V INVERT (POLARITY) CH-1 & CH-2  -----------------
!
     00  !NORMAL
     01  !INVERT

!
!-----  V MAG CH-1 & CH-2  -------------------------------

     00  !X1 (NORMAL)
     01  !X5

!
!-----  V CLAMP CH-1 & CH-2  -----------------------------
!
     00  !- CLAMP
     01  !OFF CLAMP
     02  !+ CLAMP
```

```
;
;
;=====  HORIZONTAL  ==========================================
;
;-----  H DISPLAY  ----------------------------------------
;
      00  ;B
      01  ;A INTEN BY B
      02  ;A
;
;-----  TRIG MODE  ----------------------------------------
;
      00  ;NORMAL
      01  ;AUTO
;
;-----  H MAG  --------------------------------------------
;
      00  ;X1 (NORMAL)
      01  ;X10
;
;-----  SWEEP TIME A & B  ---------------------------------
;
      00  ;0.2 ? SEC/DIV
      01  ;0.5 ? SEC/DIV
      02  ;1 ? SEC/DIV
      03  ;2 ? SEC/DIV
      04  ;5 ? SEC/DIV
      05  ;10 ? SEC/DIV
      06  ;20 ? SEC/DIV
      07  ;50 ? SEC/DIV
      08  ;100 ? SEC/DIV
      09  ;200 ? SEC/DIV
;
;-----  SWEEP TIME RANGE A & B  ---------------------------
;
      00  ;? u SEC/DIV
      01  ;? m SEC/DIV
;
;-----  SWEEP TIME VARIABLE A & B  ------------------------
;
      00  ;CAL'D
      01  ;UNCAL
;
;-----  TRIG COUPLING A & B  ------------------------------
;
      00  ;TV-V
      01  ;TV-H
      02  ;DC
      03  ;LF-REJECT
      04  ;HF-REJECT
      05  ;AC
;
;-----  TRIG SOURCE A  ------------------------------------
;
      00  ;EXT
      01  ;CH-2
      02  ;ALT
      03  ;CH-1
      04  ;LINE
;
;-----  TRIG SOURCE B  ------------------------------------
;
      00  ;EXT
      01  ;CH-2
      02  ;ALT
      03  ;CH-1
      04  ;B START AFTER DELAY
;
;-----  TRIG SLOPE A & B  ---------------------------------
;
      00  ;- TRIG
      01  ;+ TRIG
;
;-----  M HOLD OFF  ---------------------------------------
;
      00  ;B ENDS A
      01  ;HOLD OFF INC
```

9.8.4 Saving and loading data by microcomputer

Show below are the connection with LBO-5880 and PC-8000 through interface card LC-2330 and LC-2066 to save program data from an LBO-5880 into the disk of a PC-8000 connected to the LBO-5880 with PPI (80H ~ 83H), and to load data from the disk into the LBO-5880. (Optional I/O card, LC-2330 needed).



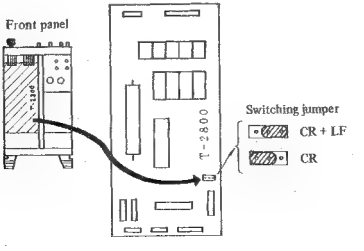
Note: The load/save program introduced on the preceding page has been created in BASIC for easy understanding.
This program may not be of much practical use because of its slow execution in BASIC.
In fact, it takes about 13 minutes 30 seconds (810 seconds) using this program to save the data in addresses 0 ~ 99 from the LBO-5880 into the PC-8000.
For increased execution speed, therefore, programming in machine language is recommended.
With a program written in machine language, it takes about 57 seconds to save the data in addresses 0 ~ 99 from the LBO-5880 into the PC-8000.
For reference, loading and saving of the same data between LBO-5880's takes about 12 seconds.

9.9 Printing Programs (PRINT)

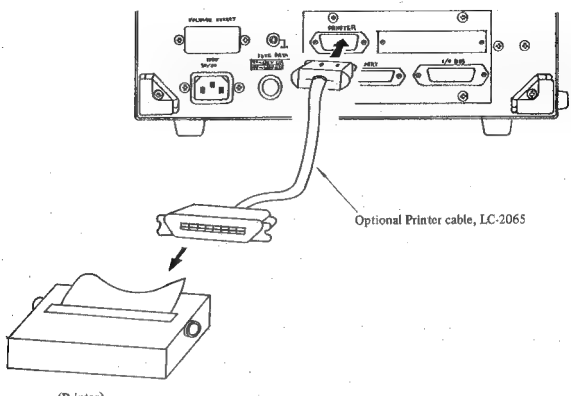
The LBO-5880 has the ability to transfer the contents of the program currently written in its internal memory to an external printer. It can also produce a hard copy of program data as desired.
Two methods of printing are supported: continuous printing of memory contents between the BEGIN and END addresses as set by OPERATING MODE switch (21) set to SET, and printing of only the memory content addressed by the displayed program address on LEDs (31) and (32) .

9.9.1 Setup

(1) The printer to be used must be one supporting a Centronix compatible printer capable of printing at least 80 characters per line.
(2) Carriage return (CR) function setting
Some printers require only the "CR" code to effect a line feed after printing a line, while others require "CR" + "LF".
The LBO-5880 supports the CR + LF type printer as standard. When the printer in use is adjustable to both CR and CR + LF, set it CR + LF.
When the printer in use is CR only, set the switching jumper inside the LBO-5880 to CR with the bottom cover open.



(3) Turn off the power to the external printer and the LBO-5880.
(4) Connect the optional printer cable as shown below.



(5) Turn on the LBO-5880 power switch (11) first.
(6) Turn on the printer power switch. (Note that if the printer is turned on before the LBO-5880, unwanted data may be transmitted to the printer when the LBO-5880 power switch is turned on later.)
(7) If using fan-fold continuous forms, align the print head with the perforations. (The LBO-5880 sets this position as the top of forms.)

9.9.2 BEGIN-END printing

(1) Perform the setup described in 9.9.1. This is not necessary if a print operation has previously been started.
(2) Set OPERATING MODE switch (22) to SET, and set the BEGIN and END addresses to print. (See 9.1 Setting BEGIN and END adrresses for detailed instruction.)
(3) Set OPERATING MODE switch (22) to PRINT.
(4) Press BEGIN/END key (25), and PL. will be dispalyed on LEDs (30) and (31) before the following title is printed.

```
--- LEADER / LBO-5880 PROGRAM LIST ---          SER. NO.(        )     PAGE ( /  )
PROG NAME (                                ),MODEL NO.(          ),PROG NO.(      )
SECTION (          ),PROGRAMMER (                ),DATE (  /  /  ),COMMENT (      )
        (---- CH-1 ----) (---- CH-2 ----)  ( HOR) (--- A SWEEP -----) (-- B SWEEP --)
           VAR    MAG      VAR    MAG      TGND     VAR      POL HDOF    VAR      POL
  VMODE     :CPL    :CLP     :CPL    :CLP    : MAG     :TGCPL  :LV :      :TGCPL  :LV
     :  ATT : : POL: : ATT : : POL: : DSP: : TIME : :TGSRC: : : TIME : :TGSRC: :
ADRS:  :  : :  :  : :  :  : :  :  : :  :  : :  :  : :  :  : :  :  : :  :  : :  :  :
```

(5) Then, the printer starts printing the program contents. The address being printed is displayed on blinking LEDs (30) and (31). (Example: 39. Address 39 is being printed.)

```
33:AL  5m C DC + 1 -  5m C DC + 1 +  B N  1 0.2u C VV EX - L B 0.2u C VV EX - L
34:AL  5m C AC + 1 /  5m C AC + 1 -  A A  1 0.2u C LF AL + L B ***** * ** ** * *
35:V1  5m C AC + 1 / *** * ** * * *  A A  1 0.2u C LF AL + L B ***** * ** ** * *
36:V2 *** * ** * * *  5m C AC + 1 -  A A  1 0.2u C LF AL + L B ***** * ** ** * *
37:AD  5m C DC + 1 /  5m C DC + 1 /  A A  1  10u C VH AL + L B ***** * ** ** * *
38:2C *** * ** * * * 0.2 C DC + 1 -  A A 10  50u C VV C2 + L B ***** * ** ** * *
39:2C *** * ** * * * 0.5 C AC + 1 +  A N 10  50u C AC EX - L B ***** * ** ** * *
```

(Sample printout)

(6) Printing stops when the program contents have been printed up to the END address.

(7) Press WRITE key (24), and the printer performs a form feed to the next top of forms position.

(8) To print other BEGIN-END addresses, repeat from step (2) downward. (Step (7) is not necessary if new program data is to be printed immediately after previous data.)

(9) A sample printout of a page is shown below.

```
--- LEADER / LBO-5800 PROGRAM LIST ---          SER. NO.(        )   PAGE (  /  )
PROG NAME (                ),MODEL NO.(                ),PROG NO.(        )
SECTION (        ).PROGRAMMER (                ),DATE (  /  /  ).COMMENT (        )
```

	(--- CH-1 ---)			(--- CH-2 ---)			(HOR)	(--- A SWEEP ---)							(-- B SWEEP --)						
	VAR		MAG	VAR		MAG	TGMD	VAR			POL	HDOF		VAR			POL			
VMODE	:CPL		:CLP	:CPL		:CLP	: MAG	:TGCPL			:LV	:		:TGCPL			:LV			
: ATT	:	POL:	: ATT	:	POL:	: DSP:	: TIME	:	TGSRC:	:	:	TIME	:	:	TGSRC:	:			
ADRS: :	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
00:V1 10m	C	DC	+	1	/	***	*	***	*	*	*	A	A	1	0.2m	C	HF	C1	+	P	N	*****	*	***	***	*	*
01:V1 20m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	2m	C	VV	E⊞	+	P	N	*****	*	***	***	*	*
02:V2 ***	*	***	*	*	*	50m	C	DC	+	1	/	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
03:1C 10m	U	AC	+	1	/	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
04:1C 0.1	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	DC	C1	+	P	N	*****	*	***	***	*	*
05:V1 0.1	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	VV	E⊞	+	P	N	*****	*	***	***	*	*
06:1C 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	*****	*	***	***	*	*
07:V1 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	+	P	N	*****	*	***	***	*	*
08:V1 10m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	DC	LI	+	P	N	*****	*	***	***	*	*
09:V1 10m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	DC	LI	+	P	N	*****	*	***	***	*	*
10:V1 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	+	P	N	*****	*	***	***	*	*
11:V1 5m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	-	P	N	*****	*	***	***	*	*
12:V1 20m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
13:1C 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	*****	*	***	***	*	*
14:V1 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	+	P	N	*****	*	***	***	*	*
15:V1 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
16:V1 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
17:V1 0.1	C	GD	+	1	-	***	*	***	*	*	*	A	N	1	5m	C	VV	C1	+	P	N	*****	*	***	***	*	*
18:V1 0.1	C	GD	+	1	-	***	*	***	*	*	*	A	N	1	5m	C	VV	C1	+	P	N	*****	*	***	***	*	*
19:V1 0.1	C	GD	+	1	-	***	*	***	*	*	*	A	N	1	5m	C	VV	C1	+	P	N	*****	*	***	***	*	*
20:V1 0.1	C	GD	+	1	-	***	*	***	*	*	*	A	N	1	5m	C	VV	C1	+	P	N	*****	*	***	***	*	*
21:1C 5m	C	AC	+	5	-	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
22:V1 5m	C	DC	+	5	-	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
23:1C 5m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
24:V1 5m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
25:V1 20m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	10u	C	VH	E⊞	+	P	N	*****	*	***	***	*	*
26:V1 20m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
27:1C 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2u	C	VH	EX	+	P	N	*****	*	***	***	*	*
28:1C 20m	C	GD	+	1	-	***	*	***	*	*	*	A	N	1	2u	C	VH	C1	+	P	N	*****	*	***	***	*	*
29:V1 20m	C	DC	+	1	-	***	*	***	*	*	*	A	N	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
30:V1 20m	C	DC	+	1	-	***	*	***	*	*	*	A	N	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
31:V1 20m	C	AC	+	1	-	***	*	***	*	*	*	A	N	1	2m	C	VV	E⊞	+	P	N	*****	*	***	***	*	*
32:AL 1	C	DC	+	1	/	5m	C	DC	+	1	/	I	A	1	20u	C	DC	C1	+	L	N	0.2u	C	DC	AD	+	L
33:AL 5m	C	DC	+	1	-	5m	C	DC	+	1	+	B	N	1	0.2u	C	VV	EX	-	L	B	0.2u	C	VV	EX	-	L
34:AL 5m	C	AC	+	1	/	5m	C	AC	+	1	-	A	A	1	0.2u	C	LF	AL	+	L	B	*****	*	***	***	*	*
35:V1 5m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	0.2u	C	LF	AL	+	L	B	*****	*	***	***	*	*
36:V2 ***	*	***	*	*	*	5m	C	AC	+	1	-	A	A	1	0.2u	C	LF	AL	+	L	B	*****	*	***	***	*	*
37:AD 5m	C	DC	+	1	/	5m	C	DC	+	1	/	A	A	1	10u	C	VH	AL	+	L	B	*****	*	***	***	*	*
38:2C ***	*	***	*	*	*	0.2	C	DC	+	1	-	A	A	10	50u	C	VV	C2	+	L	B	*****	*	***	***	*	*
39:2C ***	*	***	*	*	*	0.5	C	AC	+	1	+	A	N	10	50u	C	AC	EX	-	L	B	*****	*	***	***	*	*
40:V1 10m	C	DC	+	1	-	***	*	***	*	*	*	A	A	1	0.2m	C	HF	C1	+	P	N	*****	*	***	***	*	*
41:V1 20m	C	DC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	+	P	N	*****	*	***	***	*	*
42:V2 ***	*	***	*	*	*	50m	C	AC	+	1	/	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
43:1C 10m	U	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	*****	*	***	***	*	*
44:1C 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	*****	*	***	***	*	*
45:1C 20m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	*****	*	***	***	*	*
46:1C 50m	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	*****	*	***	***	*	*
47:1C 0.2	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	*****	*	***	***	*	*
48:V1 0.2	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	-	P	N	*****	*	***	***	*	*
49:V1 0.2	C	AC	+	1	-	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	-	P	N	*****	*	***	***	*	*

(10) When the address to print contains 50 or more lines, the printer automatically performs a form feed and prints the title at the beginning of the next page before printing the rest of the address.

(11) See 9.9.5 Print sysmbols for descriptions of the print codes.

9.9.3 SINGLE Printing

(1) Perform the setup described in 9.9.1. This is not necessary if a print operation has previously been started.

(2) Set OPERATING MODE switch (22) to PRINT.

(3) Display the address to print on LEDs (30) and (31) by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).

(Note: The address to print can be displayed only when it is in the BEGIN-END address range. Otherwise, the BEGIN and END addresses must be reset by setting OPERATING MODE switch (22) to SET.)

(4) Press SINGLE key (26) to start printing.

(Note: If the print position is at the top of forms, 戸月. is displayed on LEDs (30) and (31) and the same title as described in 9.9.2 (4) is printed before the program is printed.)

The address being printed is displayed on blinking LEDs (30) and (31).

(5) When printing of the single address is completed, the address displayed on LEDs (30) and (31) is incremented by one.

(6) To continue printing, repeat from step (3) downward.

9.9.4 Print applications

BEGIN-END printing described in 9.9.2 and SINGLE printing described in 9.9.3 can be mixed as in the following sample operations:

(1) Example 1

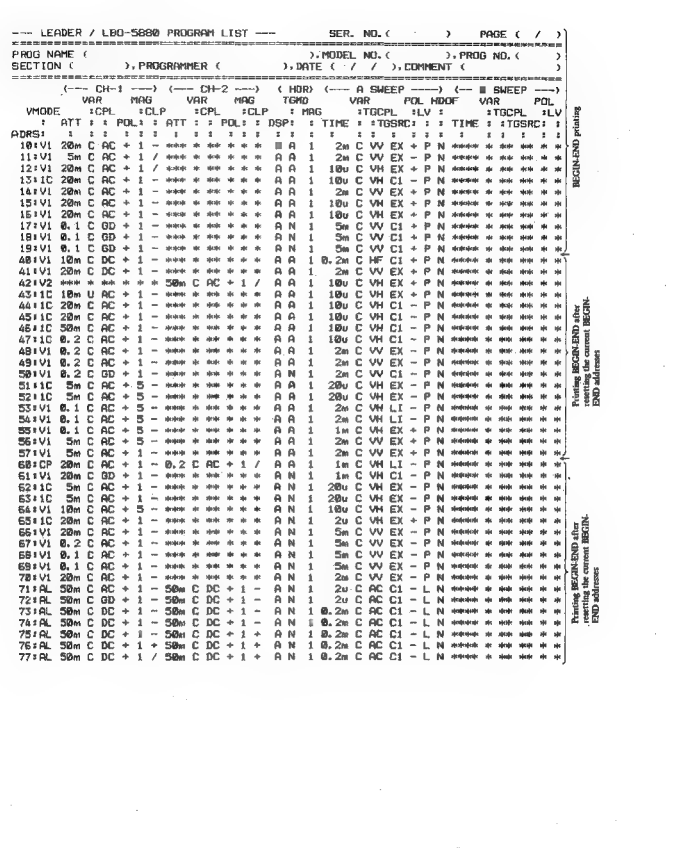
```
--- LEADER / LBO-5800 PROGRAM LIST ---          SER. NO.(     ),PAGE ( / )
PROG NAME (          ),MODEL NO.(          ),PROG NO.(          )
SECTION (          ),PROGRAMMER (          ),DATE ( / / ),COMMENT (          )
```

	(--- CH-1 ---)						(--- CH-2 ---)						(HOR)	(--- A SWEEP ----)								(-- B SWEEP ---)							
	VAR		MAG		VAR		MAG		TGMD		VAR			POL	HDOF		VAR			POL								
VMODE	:CPL		:CLP		:CPL		:CLP		: MAG		:TGCPL		:LV	:			:TGCPL		:LV									
	ATT	:	POL	:	ATT	:	POL	:	DSP	:	TIME	:	TGSRC	:	:	TIME	:	TGSRC	:									
ADRS	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:									
10	V1	20m	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	+	P	N	****	*	**	**	*	*
11	V1	5m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	-	P	N	****	*	**	**	*	*
12	V1	20m	C	AC	+	1	/	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	****	*	**	**	*	*
13	1C	20m	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	****	*	**	**	*	*
14	V1	20m	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	+	P	N	****	*	**	**	*	*
15	V1	20m	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	****	*	**	**	*	*
16	V1	20m	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	10u	C	VH	EX	+	P	N	****	*	**	**	*	*
17	V1	0.1	C	GD	+	1	~	***	*	***	*	*	*	A	N	1	5m	C	VV	C1	+	P	N	****	*	**	**	*	*
18	V1	0.1	C	GD	+	1	~	***	*	***	*	*	*	A	N	1	5m	C	VV	C1	+	P	N	****	*	**	**	*	*
19	V1	0.1	C	GD	+	1	~	***	*	***	*	*	*	A	N	1	5m	C	VV	C1	+	P	N	****	*	**	**	*	*
31	V1	20m	C	AC	+	1	~	***	*	***	*	*	*	A	N	1	2m	C	VV	EX	+	P	N	****	*	**	**	*	*
37	AD	5m	C	DC	+	1	/	5m	C	DC	+	1	/	A	A	1	10u	C	VH	AL	+	L	B	****	*	**	**	*	*
46	1C	50m	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	****	*	**	**	*	*
47	1C	0.2	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	10u	C	VH	C1	-	P	N	****	*	**	**	*	*
48	V1	0.2	C	AC	+	1	~	***	*	***	*	*	*	A	A	1	2m	C	VV	EX	-	P	N	****	*	**	**	*	*
68	CP	20m	C	AC	+	1	~	0.2	C	AC	+	1	/	A	N	1	1m	C	VH	L1	-	P	N	****	*	**	**	*	*
63	1C	5m	C	AC	+	1	~	***	*	***	*	*	*	A	N	1	20u	C	VH	EX	-	P	N	****	*	**	**	*	*
74	AL	50m	C	DC	+	1	~	50m	C	DC	+	1	~	A	N	1	0.2m	C	AC	C1	-	L	N	****	*	**	**	*	*
79	AD	50m	C	DC	+	1	/	50m	C	DC	+	1	/	A	N	1	0.2m	C	AC	C1	-	L	N	****	*	**	**	*	*
80	XY	50m	C	DC	+	1	/	50m	C	DC	+	1	/	*	*	1	****	*	**	**	*	*	*	****	*	**	**	*	*
91	2C	***	*	**	*	*	*	50m	C	DC	+	1	/	A	A	1	0.2m	C	HF	AL	+	L	N	****	*	**	**	*	*
95	2C	***	*	**	*	*	*	0.2	C	DC	+	1	/	A	A	1	0.2m	C	LF	C2	+	L	N	****	*	**	**	*	*
98	2C	***	*	**	*	*	*	5m	C	DC	+	1	~	B	N	1	0.2u	C	VV	EX	-	L	B	0.2u	C	VV	EX	-	L
99	2C	***	*	**	*	*	*	5m	C	DC	+	1	~	B	N	1	0.2u	C	VV	EX	-	L	B	0.2u	C	VV	EX	-	L

BEGIN-END printing

SINGLE printing

(2) Example 2



LEADER / L80-5800 PROGRAM LIST — SER. NO. ( ) PAGE (/)

PROG NAME ( ),MODEL NO. ( ),PROG NO. ( )

SECTION ( ),PROGRAMMER ( ),DATE (/ /),COMMENT ( )

	CH-1				CH-2				HDR	A SWEEP												B SWEEP										
	VAR		MAG		VAR		MAG		TGMD	VAR					POL	MDOF		VAR				POL										
VMODE	ATT	CPL	POL	CLP	ATT	CPL	POL	CLP	DSP	MAG	TIME	TGSRC	TGCPL	LV				TIME	TGSRC	TGCPL	LV											
ADRS																																
10	V1	20m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	+	P	N	*****	**	**	**	**	**				
11	V1	5m	C	AC	+	1	/	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
12	V1	20m	C	AC	+	1	/	****	**	**	**	**	**	A	A	1	10u	C	VH	EX	+	P	N	*****	**	**	**	**	**				
13	1C	20m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	C1	–	P	N	*****	**	**	**	**	**				
14	V1	20m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	+	P	N	*****	**	**	**	**	**				
15	V1	20m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	EX	+	P	N	*****	**	**	**	**	**				
16	V1	20m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	EX	+	P	N	*****	**	**	**	**	**				
17	V1	0.1	C	GD	+	1	–	****	**	**	**	**	**	A	N	1	5m	C	VV	C1	+	P	N	*****	**	**	**	**	**				
18	V1	0.1	C	GD	+	1	–	****	**	**	**	**	**	A	N	1	5m	C	VV	C1	+	P	N	*****	**	**	**	**	**				
19	V1	0.1	C	GD	+	1	–	****	**	**	**	**	**	A	N	1	5m	C	VV	C1	+	P	N	*****	**	**	**	**	**				
48	V1	10m	C	DC	+	1	–	****	**	**	**	**	**	A	A	1	0.2m	C	HF	C1	+	P	N	*****	**	**	**	**	**				
41	V1	20m	C	DC	+	1	–	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	+	P	N	*****	**	**	**	**	**				
42	V2	****	*	**	**	*	**	50m	C	AC	+	1	/	A	A	1	10u	C	VH	EX	+	P	N	*****	**	**	**	**	**				
43	1C	10m	U	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	EX	+	P	N	*****	**	**	**	**	**				
44	1C	20m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	C1	–	P	N	*****	**	**	**	**	**				
45	1C	20m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	C1	–	P	N	*****	**	**	**	**	**				
46	1C	50m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	C1	–	P	N	*****	**	**	**	**	**				
47	1C	0.2	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	10u	C	VH	C1	–	P	N	*****	**	**	**	**	**				
48	V1	0.2	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
49	V1	0.2	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
50	V1	0.2	C	GD	+	1	–	****	**	**	**	**	**	A	N	1	2m	C	VV	C1	–	P	N	*****	**	**	**	**	**				
51	1C	5m	C	AC	+	5	–	****	**	**	**	**	**	A	A	1	20u	C	VH	EX	–	P	N	*****	**	**	**	**	**				
52	1C	5m	C	AC	+	5	–	****	**	**	**	**	**	A	A	1	20u	C	VH	EX	–	P	N	*****	**	**	**	**	**				
53	V1	0.1	C	AC	+	5	–	****	**	**	**	**	**	A	A	1	2m	C	VH	LI	–	P	N	*****	**	**	**	**	**				
54	V1	0.1	C	AC	+	5	–	****	**	**	**	**	**	A	A	1	2m	C	VH	LI	–	P	N	*****	**	**	**	**	**				
55	V1	0.1	C	AC	+	5	–	****	**	**	**	**	**	A	A	1	1m	C	VH	EX	+	P	N	*****	**	**	**	**	**				
56	V1	5m	C	AC	+	5	–	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	+	P	N	*****	**	**	**	**	**				
57	V1	5m	C	AC	+	1	–	****	**	**	**	**	**	A	A	1	2m	C	VV	EX	+	P	N	*****	**	**	**	**	**				
60	CP	20m	C	AC	+	1	–	0.2	C	AC	+	1	/	A	A	1	1m	C	VH	LI	–	P	N	*****	**	**	**	**	**				
61	V1	20m	C	GD	+	1	–	****	**	**	**	**	**	A	N	1	1m	C	VH	C1	–	P	N	*****	**	**	**	**	**				
62	1C	5m	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	20u	C	VH	EX	–	P	N	*****	**	**	**	**	**				
63	1C	5m	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	20u	C	VH	EX	–	P	N	*****	**	**	**	**	**				
64	V1	10m	C	AC	+	5	–	****	**	**	**	**	**	A	N	1	10u	C	VH	EX	–	P	N	*****	**	**	**	**	**				
65	1C	20m	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	2u	C	VH	EX	+	P	N	*****	**	**	**	**	**				
66	V1	20m	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	5m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
67	V1	0.2	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	5m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
68	V1	0.1	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	5m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
69	V1	0.1	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	5m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
70	V1	20m	C	AC	+	1	–	****	**	**	**	**	**	A	N	1	2m	C	VV	EX	–	P	N	*****	**	**	**	**	**				
71	AL	50m	C	AC	+	1	–	50m	C	DC	+	1	–	A	N	1	2u	C	AC	C1	–	L	N	*****	**	**	**	**	**				
72	AL	50m	C	GD	+	1	–	50m	C	DC	+	1	–	A	N	1	2u	C	AC	C1	–	L	N	*****	**	**	**	**	**				
73	AL	50m	C	DC	+	1	–	50m	C	DC	+	1	–	A	N	1	0.2m	C	AC	C1	–	L	N	*****	**	**	**	**	**				
74	AL	50m	C	DC	+	1	–	50m	C	DC	+	1	–	A	N	1	0.2m	C	AC	C1	–	L	N	*****	**	**	**	**	**				
75	AL	50m	C	DC	+	1	–	50m	C	DC	+	1	+	A	N	1	0.2m	C	AC	C1	–	L	N	*****	**	**	**	**	**				
76	AL	50m	C	DC	+	1	+	50m	C	DC	+	1	+	A	N	1	0.2m	C	AC	C1	–	L	N	*****	**	**	**	**	**				
77	AL	50m	C	DC	+	1	/	50m	C	DC	+	1	+	A	N	1	0.2m	C	AC	C1	–	L	N	*****	**	**	**	**	**				

BEGIN-END printing

Printing BEGIN-END after inserting the current BEGIN-END addresses

Printing BEGIN-END after inserting the current BEGIN-END addresses

9.10 REMOTE (Address Remote Control)

This function controls the LBO-5880 program address with address codes (binary or BCD) input to the connector of rear panel I/O port (118)
It can be conveniently used to control LBO-5880 addresses in conjuction with an external device.

9.10.1 Signal line definitions

The signal designations used for the REMOTE function are listed below.

(1) ADR D7-D0: REMOTE address code input port.

(2) $\overline{\text{REM EN}}$: Synchronizing input signal used for the LBO-5880 to receive REMOTE address codes.
The LBO-5880 receives REMOTE address codes while this signal is low.

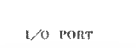
(3) BIN/$\overline{\text{BCD}}$: Input signal used for the LBO-5880 to determine whether the address codes transmitted to ADR D7-D0 are binary or BCD codes.
The signal indicates a binary code when high, a BCD code when low.

(4) $\overline{\text{PPIRES}}$: This reset signal synchronized with the LBO-5880 Power On Reset signal is used to reset an external device. It is normally high and becomes low when reset.

(5) *: Connected to the internal I/O port but not used in REMOTE.

(6) (NC): Not used

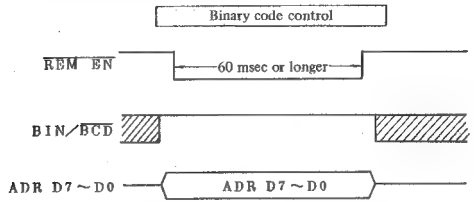
(7) GND: Signal ground level



PIN #		
1	ADR D7	(PAD7)
2	ADR D5	(PAD5)
3	ADR D3	(PAD3)
4	ADR D1	(PAD1)
5	GND	
6	GND	
7	GND	
8	GND	
9	GND	
10	GND	
11	GND	
12	GND	
13	*	(PBD7)
14	*	(PBD5)
15	*	(PBD3)
16	*	(PBD1)
17	$\overline{\text{PPIRES}}$	
18	(NC)	
19	GND	
20	ADR D6	(PAD6)
21	ADR D4	(PAD4)
22	ADR D2	(PAD2)
23	ADR D0	(PAD0)
24	*	(PCD7)
25	*	(PCD6)
26	$\overline{\text{REM EN}}$	(PCD5)
27	BIN/$\overline{\text{BCD}}$	(PCD4)
28	*	(PCD3)
29	*	(PCD2)
30	*	(PCD1)
31	*	(PCD0)
32	*	(PBD6)
33	*	(PBD4)
34	*	(PBD2)
35	*	(PBD0)
36	(NC)	
37	GND	

9.10.2 Controlling with binary code

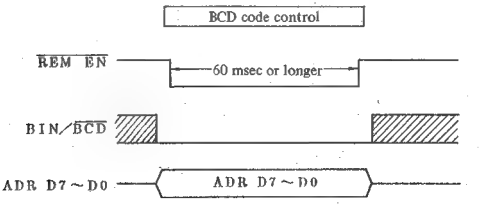
Set OPERATING MODE switch (21) to REMOTE. As shown in the timing chart below, the LBO-5880 program address can be controlled by setting I/O PORT (118) BIN/$\overline{\text{BCD}}$ to the high level, setting a binary address code in ADR D7-D0, and setting $\overline{\text{REM EN}}$ to the low level.
The address data must be generated for at least 60 msec.



(Reference) For the binary code, see 9.11.3 Address data code table.
(Note) When ADR D7-D0 are all high (floating), no address is displayed but [][]. (Control 0) is displayed on LEDs (30) and (31) instead.

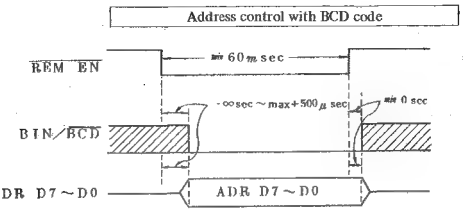
9.10.3 Controlling with BCD (binary coded decimal) code

Set OPERATING MODE switch (21) to REMOTE. As shown in the timing chart below, the LBO-5880 program address can be controlled by setting I/O PORT (118) BIN/$\overline{\text{BCD}}$ to the low level, setting a BCD address code in ADR D7-D0, and setting $\overline{\text{REM EN}}$ to the low level.
The address data must be generated for at least 60 msec.



(Reference) For the BCD code, see 9.11.3 Address data code table.
(Note) When ADR D7-D0 are all high (floating), no address is displayed but [][]. (Control 0) is displayed on LEDs (30) and (31) instead.

When it is difficult to meet the above timing conditions, the following requirements must be met. These requirements also apply to binary code, except that BIN/$\overline{\text{BCD}}$ is set to the high level.

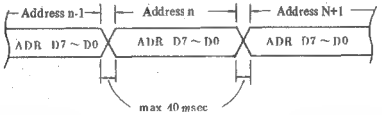


Note: In the timing chart above, $-\infty$ sec may be any value as long as it changes faster than $\overline{\text{REM EN}}$.

9.10.4 Notes on switching with a digital switch or the like

When the $\overline{\text{REM EN}}$ singnal cannot be switched because of address control switching by a digital switch or the like, the signal may be left at the low level. BIN/$\overline{\text{BCD}}$ is also fixed at either the high or low level depending on the code to be transmitted.

ADR D7-D0 timing should be limited to 40 msec or less as shown below. Chatter may occur in the LBO-5880 for an address change for 40 msec or longer; address changes for shorter periods are ignored in the LBO-5880.



9.10.5 Parallel operation

The address data output from I/O PORT (18) in the RUN PROG mode can be used to control the REMOTE address in another LBO-5880. This is because it is totally identical in format to the address data controlled in the REMOTE mode.

Therefore, if different or identical programs have been loaded in two LBO-5880's, both can be controlled concurrently by pressing INC (32) and END (37) on either LBO-5880.

The two LBO-5880's can be connected by attaching a LOAD/SAVE cable to the I/O port connector on each of them as explained in 9.6 Program Transfer (SAVE).

Set OPERATING MODE switch (21) to REMOTE on either of the two LBO-5880's. Set OPERATING MODE switch (21) to RUN PROG on the other LBO-5880 and press INC (32) and END (37), and the program addresses will be switched on the two oscilloscopes concurrently.

9.11 Address Data Output

The LBO-5880 has a function to externally output a program address while it is being accessed.

If the program address is altered by pressing either INC (32) or END (37) while the oscillator has OPERATING MODE switch (21) set to RUN PROG or CHANGE VAR's, the address is output from I/O PORT (118) on the rear panel.

The output address data is in binary and BCD (binary coded decimal) codes.

This function is used to concurrently control the LBO-5880 and an external device connected to it by using LBO-5880 program addresses.

9.11.1 Signal line definitions

The signal designations of the signals output from the I/O port are listed below.

(1) BINARY D0-D7: Binary code address data output port.

(2) BCD D0-D7: BCD code address data output port.

(3) $\overline{\text{REM EN}}$: Synchronizing input signal used to externally transmit BINARY D0-D7 and BCD D0-D7. Normally high, signal becomes low upon transmission of BINARY D0-D7 and BCD D0-D7.

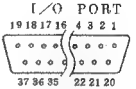
(4) $\overline{\text{PPIRES}}$: This reset signal synchronized with the LBO-5880 Power On Reset signal is used to reset an external device. It is normally high and becomes low when reset.

(5) GND: Signal ground level

(6) OPT D0-D7: Connected to the internal I/O port but has no effect on address data output.

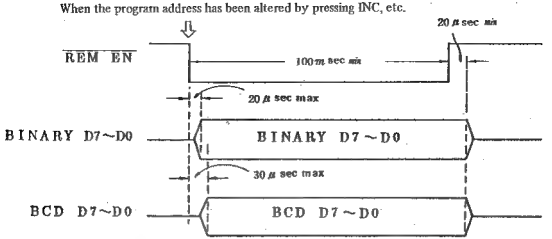
(7) NC: Not used

I/O PORT



PIN #		
1	BINARY	D 7
2	BINARY	D 5
3	BINARY	D 3
4	BINARY	D 1
5	GND	
6	GND	
7	GND	
8	GND	
9	GND	
10	GND	
11	GND	
12	GND	
13	BCD	D 7
14	BCD	D 5
15	BCD	D 3
16	BCD	D 1
17	$\overline{\text{PRIRES}}$	
18	(NC)	
19	GND	
20	BINARY	D 6
21	BINARY	D 4
22	BINARY	D 2
23	BINARY	D 0
24	OPT	D 7
25	OPT	D 6
26	$\overline{\text{REM EN}}$	
27	OPT	D 4
28	OPT	D 3
29	OPT	D 2
30	OPT	D 1
31	OPT	D 0
32	BCD	D 6
33	BCD	D 4
34	BCD	D 2
35	BCD	D 0
36	(NC)	
37	GND	

When the program address has been altered by pressing INC, etc.

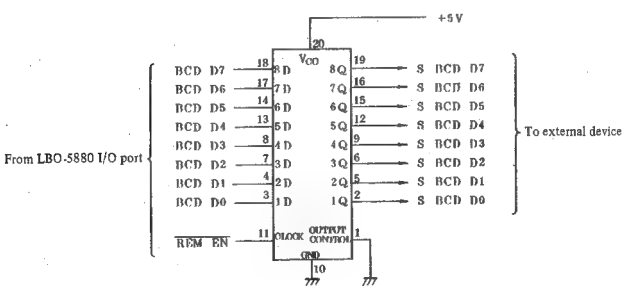


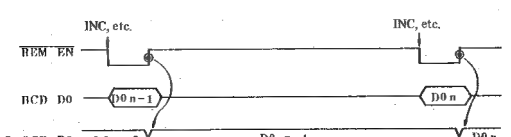
Note: Address data is undefined for at least 30 μsec after $\overline{\text{REM EN}}$ becomes low.

9.11.2 When normal address data is required

Though address data is output from the LBO-5880 rear panel I/O port for about 100 msec after the program address is altered, normal address data might be required depending on the type of connected external device.
In this situation, a latch circuit, like that explained below, should be used.

Latching BCD address data with 74LS374 (octal D-type transparent latches and edge-triggered flip flops)





9.11.3 Address data code table

LBO-5880 BINARY and BCD ADDRESS DATA

ADRS	BIN D7-D0 7654 3210	BCD D7-D0 7654 3210	ADRS	BIN D7-D0 7654 3210	BCD D7-D0 7654 3210
(0)	0000 0000	0000 0000	(50)	0011 0010	0101 0000
(1)	0000 0001	0000 0001	(51)	0011 0011	0101 0001
(2)	0000 0010	0000 0010	(52)	0011 0100	0101 0010
(3)	0000 0011	0000 0011	(53)	0011 0101	0101 0011
(4)	0000 0100	0000 0100	(54)	0011 0110	0101 0100
(5)	0000 0101	0000 0101	(55)	0011 0111	0101 0101
(6)	0000 0110	0000 0110	(56)	0011 1000	0101 0110
(7)	0000 0111	0000 0111	(57)	0011 1001	0101 0111
(8)	0000 1000	0000 1000	(58)	0011 1010	0101 1000
(9)	0000 1001	0000 1001	(59)	0011 1011	0101 1001
(10)	0000 1010	0001 0000	(60)	0011 1100	0110 0000
(11)	0000 1011	0001 0001	(61)	0011 1101	0110 0001
(12)	0000 1100	0001 0010	(62)	0011 1110	0110 0010
(13)	0000 1101	0001 0011	(63)	0011 1111	0110 0011
(14)	0000 1110	0001 0100	(64)	0100 0000	0110 0100
(15)	0000 1111	0001 0101	(65)	0100 0001	0110 0101
(16)	0001 0000	0001 0110	(66)	0100 0010	0110 0110
(17)	0001 0001	0001 0111	(67)	0100 0011	0110 0111
(18)	0001 0010	0001 1000	(68)	0100 0100	0110 1000
(19)	0001 0011	0001 1001	(69)	0100 0101	0110 1001
(20)	0001 0100	0010 0000	(70)	0100 0110	0111 0000
(21)	0001 0101	0010 0001	(71)	0100 0111	0111 0001
(22)	0001 0110	0010 0010	(72)	0100 1000	0111 0010
(23)	0001 0111	0010 0011	(73)	0100 1001	0111 0011
(24)	0001 1000	0010 0100	(74)	0100 1010	0111 0100
(25)	0001 1001	0010 0101	(75)	0100 1011	0111 0101
(26)	0001 1010	0010 0110	(76)	0100 1100	0111 0110
(27)	0001 1011	0010 0111	(77)	0100 1101	0111 0111
(28)	0001 1100	0010 1000	(78)	0100 1110	0111 1000
(29)	0001 1101	0010 1001	(79)	0100 1111	0111 1001
(30)	0001 1110	0011 0000	(80)	0101 0000	1000 0000
(31)	0001 1111	0011 0001	(81)	0101 0001	1000 0001
(32)	0010 0000	0011 0010	(82)	0101 0010	1000 0010
(33)	0010 0001	0011 0011	(83)	0101 0011	1000 0011
(34)	0010 0010	0011 0100	(84)	0101 0100	1000 0100
(35)	0010 0011	0011 0101	(85)	0101 0101	1000 0101
(36)	0010 0100	0011 0110	(86)	0101 0110	1000 0110
(37)	0010 0101	0011 0111	(87)	0101 0111	1000 0111
(38)	0010 0110	0011 1000	(88)	0101 1000	1000 1000
(39)	0010 0111	0011 1001	(89)	0101 1001	1000 1001
(40)	0010 1000	0100 0000	(90)	0101 1010	1001 0000
(41)	0010 1001	0100 0001	(91)	0101 1011	1001 0001
(42)	0010 1010	0100 0010	(92)	0101 1100	1001 0010
(43)	0010 1011	0100 0011	(93)	0101 1101	1001 0011
(44)	0010 1100	0100 0100	(94)	0101 1110	1001 0100
(45)	0010 1101	0100 0101	(95)	0101 1111	1001 0101
(46)	0010 1110	0100 0110	(96)	0110 0000	1001 0110
(47)	0010 1111	0100 0111	(97)	0110 0001	1001 0111
(48)	0011 0000	0100 1000	(98)	0110 0010	1001 1000
(49)	0011 0001	0100 1001	(99)	0110 0011	1001 1001

9.12 External Control (EXT CONTROL) Procedures

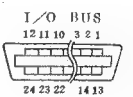
The LBO-5880 has I/O BUS (119) installed at the rear-panel connector shown in the figure below. External control of a device, etc., is made possible by attaching a simple external circuit to this bus to suit a particular application.

A total of up to 64 bits can be exteranally controlled. If all these bits are used, 2^{64} (1.84×10^{19}) code patterns can be obtained.

9.12.1 Signal line definitions

(1) XIO D7-D0: External control 8-bit data bus, through which external control data is read into the LBO-5880, or is externally output from internal memory.

Note: Since this bus is connected to the Z80 CPU bus in the LBO-5880, improper use of the bus could disable not only the external control but all other functions.



SIGNAL	PIN #
X IO D0	1
X IO D1	13
X IO D2	2
X IO D3	14
X IO D4	3
X IO D5	15
X IO D6	4
X IO D7	16
GND	5
GND	17
X IN	6
X OUT	18
X IORES	7
X IO A0	19
X IO A1	8
X IO A2	20
X IO A3	9
X IO A4	21
GND	10
GND	22
X INC	11
X DEC	23
X WAIT	12
+5V	24

(2) XIN: Becomes low when the LBO-5880 reads external control data from the I/O bus. (It goes low when the Z80 executes IORD 60H ~ 7FH.)

(3) XOUT: Becomes low when the LBO-5880 outputs external control data to the I/O bus. (It goes low when the Z80 executes IOWR 60H ~ 7FH.)

(4) XIORES: This reset signal synchronized with the LBO-5880 Power On Reset signal is used to reset an external device. It is normally high and becomes low when reset.

(5) XIO A4-A0: A total of 64 available bits for external control by the LBO-5880 is grouped into eight blocks. Each block is 8 bits long. XIO A4-A0 determines the addresses of the eight blocks. (They are also used for Z80 address bus A4-A0.)

(6) XINC: Signal to increment the LBO-5880 program address by one step. The program address is incremented (INC) when this signal becomes low.

(7) XDEC: Signal to decrement the LBO-5880 program address by one step. The program address is decremented when this signal becomes low.

(8) XWAIT: Normally not used

This is used when reading external control signal data from the I/O bus into a slow external device.

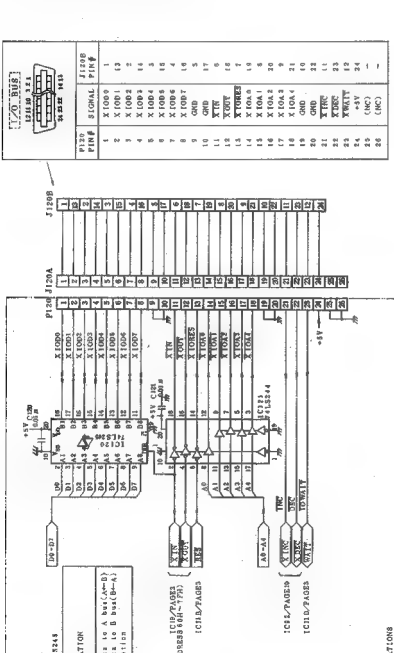
XWAIT becomes low when data output is received from the I/O bus. (This is connected to Z80 CPU WAIT.)

(9) GND: Signal ground level

(10) +5V: +5V power output pin.
This +5V power supply should be used only for setting pull-up levels, etc., and not as a power supply for an exteranl circuit. Note that excessive current flow could inhibit normal LBO-5880 performance.

9.12.2 I/O BUS internal circuit diagram

A block diagram of the LBO-5880 bus internal circuit is shown below.



9.12.3 Example of an external circuit and usage

(1) Writing to memory

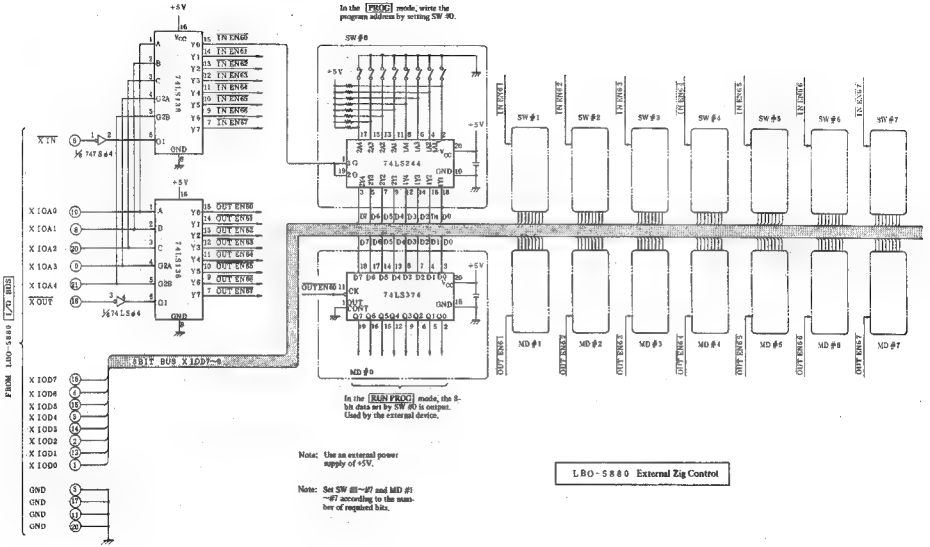
(a) Perform steps (1) through (4) described in 9.2 Writing To Memory.

(b) Set external control device SW #0 ~ #7 for the data to be written. Note that data will not be read into the LBO-5880 if all controls with [PTP] switches are pushed at this time. To ensure writing, pull at least one [PTP] SW, such as INTEN.

(c) Perform steps (5) and (6) described in 9.2 Writing To Memory.

(2) Calling from memory

(a) Set OPERATING MODE switch (21) to RUN PROG or CHANGE VAR's, and call the desired address by pressing INC (32) and END (37). The data stored at this address will then be output from external control device MD #0 ~ #7 connected to I/O BUS (119)


In the PROG mode, write the program address by setting SW #0.
SW #0
+5V
74LS244
74LS374
74LS138
74LS04
GND
X IN
X IOA9
X IOA1
X IOA2
X IOA3
X IOA4
X OUT
8BIT BUS X1DD7~0
X IOD7
X IOD6
X IOD5
X IOD4
X IOD3
X IOD2
X IOD1
X IOD0
GND
GND
GND
GND
FROM LBO-5880 I/O BUS
IN EN#7
IN EN#6
IN EN#5
IN EN#4
IN EN#3
IN EN#2
IN EN#1
SW #7
SW #6
SW #5
SW #4
SW #3
SW #2
SW #1
OUT EN#7
OUT EN#6
OUT EN#5
OUT EN#4
OUT EN#3
OUT EN#2
OUT EN#1
MD #7
MD #6
MD #5
MD #4
MD #3
MD #2
MD #1
MD #0
In the RUN PROG mode, the 8-bit data set by SW #0 is output. Used by the external device.
Note: Use an external power supply of +5V.
Note: Set SW #0~#7 and MD #1 ~#7 according to the number of required bits.
LBO-5880 External Zig Control

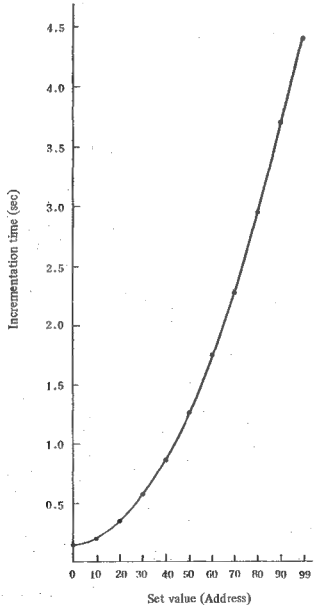
9.13 AUTO INC

The LBO-5880 has an automatic address incrementation function by which addresses can be automatically incremented without pressing INC key (32) . The incrementation time can be arbitrarily set by the user.

(1) Set OPERATING MODE switch (22) to SET, and set the BEGIN and END addresses. (For further details see 9.1 Setting BEGIN and END Addressesses.)

(2) In the SET mode, display a value on seven-segment LEDs (30) and (31) by pressing INC (32) and END (37) . This value indicates the incrementation time. A rough relationship exists between the value set on the LEDs and the incrementation time shown in the graph below.

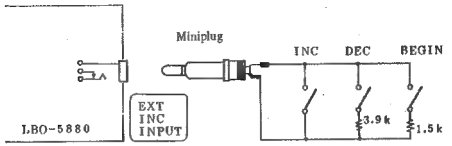
(3) Set OPERATING MODE switch (22) to FUNC 1 to start automatic incrementation.



9.14 EXT INC, DEC, and BEGIN

9.14.1 INC, DEC, and BEGIN by EXT INC INPUT

Addresses can be controlled by connecting an exteranl switch to EXT INC INPUT jack (38) .

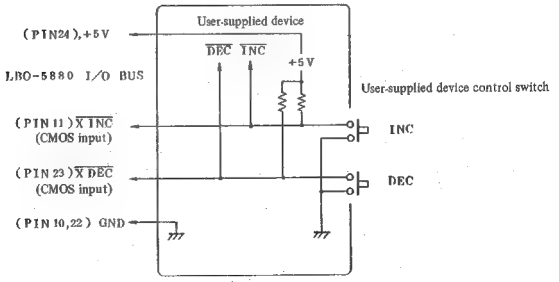


The INC mode is set by shorting the input pin as shown above; the DEC mode, by shorting the input pin with a 3.9 kΩ resister, and the BIGIN mode, by shorting the input pin with a 1.5 kΩ resistor.

(Reference) The control box (LBO-5880-03) is optionally available to remotely control INC, DEC, and BEGIN operations.

9.14.2 INC, DEC, and BEGIN via I/O BUS

In the setup shown below, LBO-5880 addresses are controlled via the I/O bus interlocked with a user-supplied device control switch.



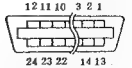
$\overline{\text{XINC}}$: Signal to increment the LBO-5880 program address by one step from an external device. The program address is incremented (INC) when this signal becomes low.

$\overline{\text{XDEC}}$: Signal to decrement the LBO-5880 program address by one step from an external device. The program address is decremented (DEC) when this signal becomes low.

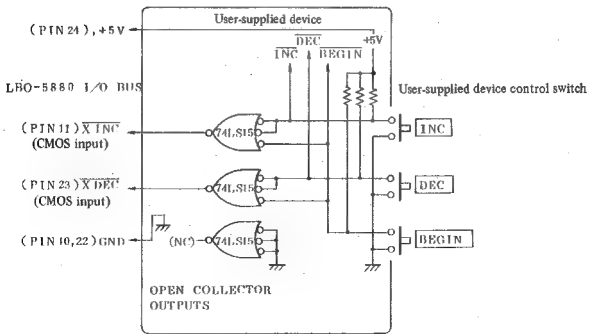
GND: Signal ground level

Setting $\overline{\text{XINC}}$ and $\overline{\text{XDEC}}$ to the low level at the same time performs the same function as BEGIN (36). When the user-supplied device has a BEGIN switch, INC, DEC, and BEGIN operations can be controlled in the wiring setup as shown below.

I/O BUS



SIGNAL	PIN #
X IO D 0	1
X IO D 1	13
X IO D 2	2
X IO D 3	14
X IO D 4	3
X IO D 5	15
X IO D 6	4
X IO D 7	16
GND	5
GND	17
$\overline{\text{X IN}}$	6
$\overline{\text{X OUT}}$	18
$\overline{\text{X IO RES}}$	7
X IO A 0	19
X IO A 1	8
X IO A 2	20
X IO A 3	9
X IO A 4	21
GND	10
GND	22
← $\overline{\text{X INC}}$	11
← $\overline{\text{X DEC}}$	23
$\overline{\text{X WAIT}}$	12
+5 V	24



9.14.3 INC, DEC, and BEGIN by PC board connector

The method of performing INC, DEC, and BEGIN operations in the method explained in 9.14.2 is difficult to do when the I/O bus is used by the probe selector and EXT control (unless two connectors are used in parallel).

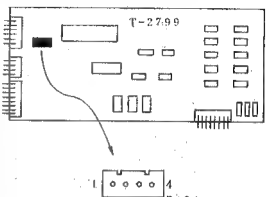
To provide for this situation, an INC, DEC, and BEGIN input connector is provided separately from PC board T-2799 in the LBO-5880.

$\overline{\text{INC}}$: Signal to increment the LBO-5880 program address by one step from an external device. The program address is incremented (INC) when this signal becomes low.

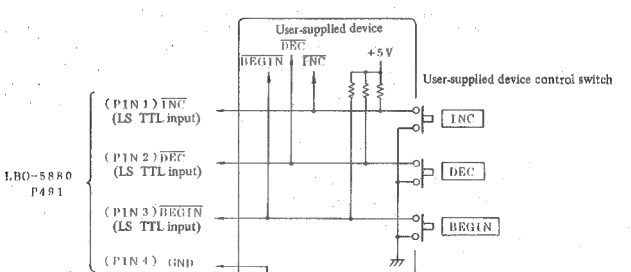
$\overline{\text{DEC}}$: Signal to decrement the LBO-5880 program address by one step from an external device. The program address is decremented when this signal becomes low.

$\overline{\text{BEGIN}}$: Signal to return the LBO-5880 program address to the BEGIN address from an external device. The BEGIN address is set when this signal becomes low.

GND: Signal ground level



PIN #	SIGNAL
1	$\overline{\text{INC}}$
2	$\overline{\text{DEC}}$
3	$\overline{\text{BEGIN}}$
4	GND



9.15 Recalling Program [ABORT] + [END]

If the user should set OPERATING MODE switch (21) to RUN PROG without pressing WRITE key (24) after setting a program with the OPERATING MODE switch being set to PROG, the previously set program data would be lost when the program data at the program address, prior to being rewritten, is called. The LBO-5880, however, stores this program data in the last memory address to be recalled.

<Operation>

(1) Return OPERATING MODE switch (21) to PROG.

(2) Press END (37) while holding down ABORT (27), and the program data previously set in the PROG mode is recalled.

9.16 Memory Write Protection

Memory contents can be easily rewritten by simply pressing WRITE key (24) after setting OPERATING MODE switch (21) to PROG.

This means that a useful program could be altered if WRITE key (24) were accidentally touched while OPERATING MODE switch (21) is set to PROG or CHANGE VAR'S.

The LBO-5880 provides a memory write protection function to provide against such accidental program alteration.

9.16.1 Setting write protection

If write protection is set, writing to memory is prevented even when WRITE key (24) is pressed by setting OPERATING MODE switch (21) to PROG or CHANGE VAR'S. Once this function is set, write protection is preserved even after power is turned off.

[Setting procedure]

(1) Set OPERATING MODE switch (21) to SET.

(2) While holding down WRITE key (24), press INC (32), DEC (33), INC 10 (34), DEC 10 (35), BEGIN (36), and END (37) in this order.

(3) Write protection is set with "PP" being displayed on LEDs (30) and (31).

Notes: 1) Be careful not to press WRITE key (24) with OPERATING MODE switch (21) set to PROG. The program would be altered. Keep OPERATING MODE switch (21) set to SET.

2) Write protection setting will be cancelled if WRITE key (24) is released during operation (2), and error "42" is displayed on LEDs (30) and (31) to indicate termination of the write protection setting.

9.16.2 Resetting write protection

Write protection must be reset before data can be written to memory. Error "41" will be displayed if the WRITE key is pressed without write protection being reset.

[Setting procedure]

(1) Set OPERATING MODE switch (21) to SET.

(2) While holding down WRITE key (24), press END (37), BEGIN (36), DEC 10 (35), INC 10 (34), DEC (33), and INC (32) in this order.

(3) Write protection is reset with "UU" being displayed on LEDs (30) and (31).

Notes: 1) Be careful not to press WRITE key (24) with OPERATING MODE switch (21) set to PROG. The program would be altered. Keep OPERATING MODE switch (21) set to SET.

2) Write protection resetting will be cancelled if WRITE key (24) is released during operation (2), and error "43" is displayed on LEDs (30) and (31) to indicate termination of the write protection resetting.

9.16.3 Checking write protection status

When LBO-5880 POWER switch (11) is turned on, any of the following symbols is displayed on LEDs (30) and (31) for about 0.5 second to indicate the write protection status:

P P Memory protection on (Protected)

U U Memory protection off (Unprotected)

If writing to memory is attempted with write protection on, error "41" will be displayed blinking, accompanied by an audible alarm to indicate that write protection is set.

10. CHECKING FUNCTIONS

The LBO-5880 provides various self-checks to verify normal function operation.
Some of these checks are automatically performed when POWER switch (11) is turned on, while others are performed automatically when check keys are pressed.

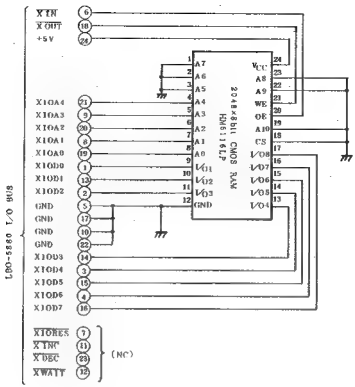
10.1 Automatic Checks

- RAM 4 (CPU system memory) read/write check
- RAM 0 ~3 (backup program memory) data error check
- 7-segment LED (program address display) display test
- D/A converter flag check
- OPERATING MODE switch check

In addition, checks are also made depending on the setting of OPERATING MODE switch (21). For these checks see Chapter 12. Error Messages.

10.2 I/O BUS Check [FUNC 3] + [INC]

This is used to check LBO-5880 rear-panel I/O BUS (19).
Since various expansion peripherals, rather than a particular device, could be connected to the I/O bus to enhance the LBO-5880 functions, the bus is checked by connecting a memory IC to it in the setup shown below.



(1) Connect a memory IC to rear-panel I/O BUS (19) .
(2) Set OPERATING MODE switch (21) to FUNC 3.
(3) Press INC (32) , and data is written to the memory IC from I/O BUS (19) . Then data is read out to check against the write data. (Checking is made at all addresses XIOA4 ~ XIOA0.)
(4) If checking is successful, 00 (OK) is displayed on LEDs (30) and (31) ; if an error occurs, n n (NG) is displayed.

10.3 OPERATING MODE Switch Check FUNC 3 + DEC

This is to verify normal operation of LBO-5880 OPERATING MODE switch (21) (in other words to determine whether normal switch data is read into the internal CPU or not).

(1) Set OPERATING MODE switch (21) to FUNC 3
(2) Press DEC key (33) to set the check mode, and the current operating mode is displayed on 7-segment LEDs (30) and (31) as shown in the table to the right.
(3) Set OPERATING MODE switch (21) to all other positions and check for the resulting displays. The switch is functioning normally if the corresponding modes are displayed as shown in the table to the right.
(4) Press ABORT key (27) , and F 3 (FUNC 3) will be displayed on 7-segment LEDs (30) and (31) , and the LBO-5880 returns to normal status.
Even though ABORT key (27) is not pressed, the LBO-5880 returns to normal status automatically if the OPERATING MODE switch is not operated for about 10 seconds or longer.

OPERATING MODE switch	Display
REMOTE	– 0
FUNC 1	– 1
" 2	– 2
" 3	– 3
PRINT	– 4
LOAD	– 5
SAVE	– 6
SET	– 7
PROG	– 8
CHANGE VAR'S	– 9
RUN PROG	– A
MANUAL	– b

Note: The check mode is not set unless the OPERATING MODE switch is set to FUNC 3. This is, however, contradictory because the switch cannot be checked when it has a malfunction and therefore cannot be set to FUNC 3.
In this case, turn POWER switch (11) off and turn it on again while holding down GND TEST (CH-2) (68) . The check mode is set as GND TEST (68) is held down, and any one of the codes shown in the above table is displaed on LEDs (30) and (31) . Then, perform steps (3) and (4).

10.4 Memory Control Check [FUNC 3] + [INC 10]

This is to verify normal operation of the LBO-5880 memory control keys, INC (32) , END (36) , WRITE (26) , and ABORT (24) (in other words to determine whether normal key data is read into the internal CPU or not).

(1) Set OPERATING MODE switch (21) to FUNC 3.

(2) Press INC 10 key (34) to set the check mode, and the data set by the memory control keys is displayed on 7-segment LEDs (30) and (31) as shwon in the table to the right.

(3) Try all memory control keys and if all key data is displayed as shown in the table, set OPERATING MODE switch (21) to FUNC 2 or PRINT, then to FUNC 3. F 3(FUNC 3) will then be displayed on 7-segment LEDs (30) and (31) and the LBO-5880 returns to normal status.
(Pressing the ABORT key does not return the LBO-5880 to normal status, because it is used in the key test.) The LBO-5880 will return to normal status automatically if no memory control key is pressed for about 10 seconds or longer.

Memory control key	Display
INC	0
DEC	1
INC 10	2
DEC 10	3
BEGIN	4
END	5
WRITE	6
INSERT	7
DELETE	8
ABORT	9

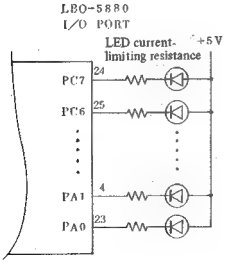
10.5 I/O PORT Check [FUNC 3] + [DEC 10]

This is used to check data signals output from I/O PORT (118) on the LBO-5880 rear panel. Usually, checking is done by connecting LEDs to the port and viewing the indications displayed by the LEDs.

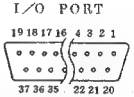
LED ⇩	A7 B7 C7	A6 B6 C6	A5 B5 C5	A4 B4 C4	A3 B3 C3	A2 B2 C2	A1 B1 C1	A0 B0 C0
P7	0	1	1	1	1	1	1	1
P6	1	0	1	1	1	1	1	1
P5	1	1	0	1	1	1	1	1
P4	1	1	1	0	1	1	1	1
P3	1	1	1	1	0	1	1	1
P2	1	1	1	1	1	0	1	1
P1	1	1	1	1	1	1	0	1
P0	1	1	1	1	1	1	1	0

(1) Set OPERATING MODE switch (21) to FUNC 3.
(2) Press DEC 10 key (35) to set the check mode, and the above described data is output from I/O PORT (118).

Checking can be simplified by having LEDs connected to the port as shown below.



I/O PORT



SIGNAL	PIN #
PA 7	1
PA 5	2
PA 3	3
PA 1	4
GND	5
GND	6
GND	7
GND	8
GND	9
GND	10
GND	11
GND	12
PB 7	13
PB 5	14
PB 3	15
PB 1	16
$\overline{\text{PPIRES}}$	17
(NC)	18
GND	19
PA 6	20
PA 4	21
PA 2	22
PA 0	23
PC 7	24
PC 6	25
PC 5	26
PC 4	27
PC 3	28
PC 2	29
PC 1	30
PC 0	31
PB 6	32
PB 4	33
PB 2	34
PB 0	35
(NC)	36
GND	37

(3) P7 (Pattern 7) to P0 (Pattern 0) are displayed on 7-segment LEDs (30) and (31) at about one-second intervals and the corresponding data is output.

(4) When up to P0 is displayed, F3 (FUNC 3) is redisplayed on 7-segment LEDs (30) and (31) and the LBO-5880 returns to normal status.

Note: To terminate checking in progress, press ABORT key (27), and the LBO-5880 will return to the normal status in step (4) above.

10.6 7-segment LED Check FUNC 3 + BEGIN

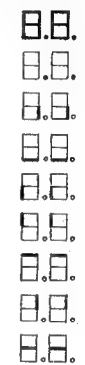
This is used to check for lighting of 7-segment LEDs (30) and (31) on the LBO-5880 front panel.

(1) Set OPERATING MODE switch (21) to FUNC 3.

(2) Press BEGIN key (36) to set the check mode, and 7-segment LEDs (30) and (31) will sequentially light in 0.5 second intervals as shown to the right.

(3) When the last pattern is displayed, F3 (FUNC 3) is redisplayed on 7-segment LEDs (30) and (31) and the LBO-5880 returns to normal status.

Note: To terminate checking in progress, press ABORT key (27) a little longer than usual, and the LBO-5880 will return to the normal status in step (3) above.



10.7 Oscilloscope Control Key Check FUNC 3 + END

This is used to verify normal operation of the oscilloscope control keys on the LBO-5880 front right panel (in other words, to determine whether normal key data is read into the internal CPU or not).

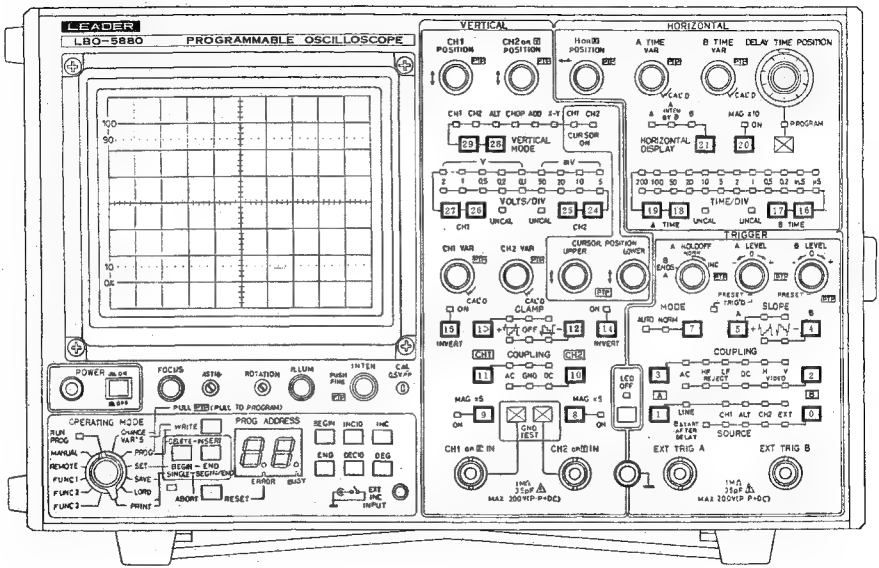
(1) Press OPERATING MODE switch (21) to FUNC 3.

(2) Press END key (37), and the test mode is set with 0. being displayed on 7-segment LEDs (30) and (31).

(3) Press the oscilloscope control keys, and check if the corresponding display data is displayed as shown in the diagram on the next page.
For example, if the CH-1 MAG × 5 key is pressed, 9. should be displayed on 7-segment LEDs (30) and (31).

(4) Try all oscilloscope control keys. If all are successfully checked, press ABORT key (27) then F3 (FUNC 3) will be displayed on 7-segment LEDs (30) and (31), and the LBO-5880 returns to normal status.
Even though ABORT key (27) is not pressed, the LBO-5880 returns to normal status automatically if no oscilloscope control key is pressed for about 10 seconds or longer.

Oscilloscope control key check (□ shows data displayed.)



Note: No display appears if keys marked ☒ are pressed.

10.8 Printer Bus Check [FUNC 3] + [WRITE]

This is used to check PRINTER bus (117) on the LBO-5880 rear panel (and also test the connected printer).

(1) Turn off LBO-5880 POWER switch (11), and connect an external printer to PRINTER bus (117).
For cabling and other instructions, see 9.9 Printng Programs.

(2) Turn on LBO-5880 POWER switch (11)

(3) Turn on the power switch of the external printer.

(4) Press WRITE key (24), and PC (Print Character) is displayed on 7-segment LEDs (30) and (31), and the following characters are printed on the printer:

(Sample printout)

```
!"#$%&' ()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
```

(5) When printing is completed, F3 (FUNC 3) is redisplayed on 7-segment LEDs (30) and (31), and the LBO-5880 returns to normal status.

Note: To terminate checking in progress, press ABORT key (27), and the LBO-5880 will return to the normal status in step (5) above.

10.9 Audible Alarm and Blinking LED Check [FUNC 3] + [INSERT]

This is used to check the audible alarm drive circuit of the LBO-5880 LEDs and the blinking circuit of the 7-segment LEDs.

(1) Set OPERATING MODE switch (21) to FUNC 3.

(2) Press INSERT key (25) to set the test mode, and b0 (Beep 0) is initially displayed on 7-segment LEDs (30) and (31). For b0 (Beep 0), an audible alarm tone is sounded from the audible alarm (23) for about 1.5 seconds.

(3) Press INSERT key (25) repeatedly, and the audible alarm tones specified in the table to the right should be sounded. b9 through bC are used for a LED blinking test to check if data displayed on 7-segment LEDs (30) and (31) blinks or not.

(4) When all checks for b0 through bC are completed, press ABORT key (27) and F3 (FUNC 3) will be displayed on 7-segment LEDs (30) and (31), and the LBO-5880 returns to normal status.
Even though ABORT key (27) is not pressed, the LBO-5880 returns to normal status automatically if INSERT key (25) is not pressed for about 10 seconds or longer.

Display	Operation
b0	(Stop) (Approx. 1.5 sec)
b1	(Stop))
b2	(Very short)
b3	(Continuous)
b4	Off
b5	(Continuous)
b6	(Continuous)
b7	(Stop) (Approx. 1.5 sec)
b8	(Stop) (Approx. 1.5 sec)
b9	LEDs do not blink.
bA	Low-order LED blinks
bb	High-order LED blinks.
bC	Both LEDs blink.

10.10 Program ROM Version Number Display [FUNC 3] + [DELETE]

The program ROM version may be updated to reflect functional improvements made on the LBO-5880 or changes in its specifications. This function is used to display the version number of the current ROM incorporated in the LBO-5880 main unit.

(1) Set OPERATING MODE switch (21) to FUNC 3.

(2) Press DELETE key (26), and the ROM version number will be displayed on blinking 7-segment LEDs (30) and (31).

(3) A few seconds later, F3 (FUNC 3) is displayed on the LEDs.

(Display example)  (Version 1.2)

10.11 Printing Code Table [FUNC 2] + [INC]

This is used to print the code table describing the program data (represented by simple symbols) to be printed on an external printer in the PRINT mode (21). See 9.9.6 Printing code table for further information.

Note: This is not a checking function, but is a functional enhancement of the LBO-5880.

10.12 [PTP] Switch Check [FUNC 2] + [DEC]

This is used to verify normal operation of the push switches that control the [PTP] switches and rotary switches on the LBO-5880 panel (in other words, to determine whether normal key data is read into the internal CPU or not).

Variable data is converted from analog to digital by the A/D converter and read into the internal CPU. The data is not controlled unless the [PTP] switch is pulled or unless the A/D coverter is normal. This check serves to determine which is faulty, the A/D converter or [PTP] switch.

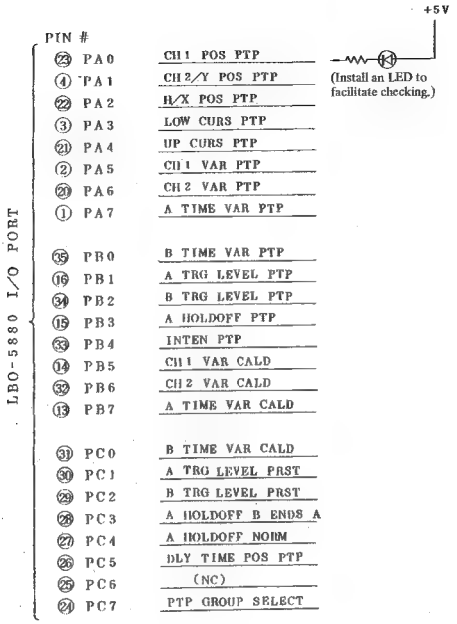
Data on rotary switches, such as CAL'D and PRESET, can also be checked.

(1) Set OPERATING MODE switch (21) to FUNC 2.

(2) Press DEC key (33) to set the check mode, and PL (Pull) is displayed on 7-segment LEDs (30) and (31), with the switch status being output from I/O PORT (118). See below for the correspondence between output data and pins.

(3) When all [PTP] switches, and the CAL'D and PRESET switches have been checked, press ABORT key (27) and F2 (FUNC 2) will be displayed on 7-segment LEDs (30) and (31), and the LBO-5880 returns to normal status.

Even though ABORT key (27) is not pressed, the LBO-5880 returns to normal status automatically if the switch status is unchanged for about 10 seconds or longer.



Note: PTP Group Select goes low when any of the PTP switches is pulled, low when CAL'D, and low when PRESET. PTPs are low when pulled.

10.13 External Oscilloscope Control [FUNC 2] + [INC 10]

This is to control the LBO-5880 oscilloscope with externally supplied data.
Enter single-program address data (80 bytes) from an external source and the internal oscilloscope function is set according to the input data.

10.13.1 Signal Line Definitions

The designations of the signals used to connect the LBO-5880 to an external are listed below.

(1) LSD7-D0: 8-bit input port used to input single-program address data (80 bytes).

(2) $\overline{\text{STROBE}}$: Synchronizing signal for receiving LSD7-D0. The LBO-5880 receives the LSD7-D0 data set by an external device when STROBE is low.

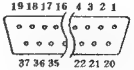
(3) $\overline{\text{READY}}$: Signal to request data transmission from an external device. The external device must not transmit data while this signal is high.

(4) $\overline{\text{PPIRES}}$: Reset signal synchronized with the LBO-5880 Power On Reset signal.
Normally not used. Used when the need arises to reset the external device at the same time.

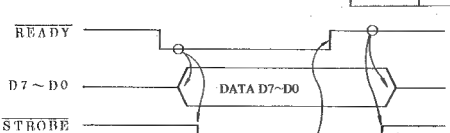
(5) *: Connected to the internal I/O port but not used here.

(6) (NC): Not used

(7) GND: Signal ground level



PIN #		
1	LSD7	(PAD7)
2	LSD5	(PAD5)
3	LSD3	(PAD3)
4	LSD1	(PAD1)
5	GND	
6	GND	
7	GND	
8	GND	
9	GND	
10	GND	
11	GND	
12	GND	
13	*	(PBD7)
14	*	(PBD5)
15	*	(PBD3)
16	*	(PBD1)
17	$\overline{\text{PPIRES}}$	
18	(NC)	
19	GND	
20	LSD6	(PAD6)
21	LSD4	(PAD4)
22	LSD2	(PAD2)
23	LSD0	(PAD0)
24	$\overline{\text{STROBE}}$	(PCD7)
25	*	(PCD6)
26	*	(PCD5)
27	*	(PCD4)
28	*	(PCD3)
29	*	(PCD2)
30	*	(PCD1)
31	$\overline{\text{READY}}$	(PCD0)
32	*	(PBD6)
33	*	(PBD4)
34	*	(PBD2)
35	*	(PBD0)
36	(NC)	
37	GND	



10.13.2 Application of external data oscilloscope control

The preceding discussions may have given the reader an idea of the method of controlling the oscilloscope externally. The laborious and timing-consuming preparation of control data involved in controlling the oscilloscope with an external controller (such as a microcomputer) can be simplified in the following way:

Program data created on the LBO-5880 is transferred to the external controller in a required quantity by SINGLE SAVE. (See 9.8.4 Saving and loading data by a microcomputer for further details.)

The controller stores the received data in a storage device (as a data file on a floppy disk, for example), so that it can control the LBO-5880 easily by transmitting the data to the LBO-5880 as control data when necessary.

When the program address requires more than 100 steps (0 ~ 99), more steps can be added as needed as long as storage space is available on the external controller.

(1) Before turning on LBO-5880 POWER switch (11), connect required control signals to an external controller (such as a microcomputer). See the preceding discussions for the signal and pin number relationships.

(2) Turn on LBO-5880 POWER switch (11).

(3) When memory is write protected, reset it as described in 9.16.2 Resetting write protection.

Note that the data at address 99 is rewritten as external control data is transferred to program address 99 memory.

(4) Set OPERATING MODE switch (21) to FUNC 2.

(5) Press INC 10 key (34), and C 1. (Control 1) is displayed on blinking 7-segment LEDs (30) and (31).

(6) Externally transmit single program address data to LBO-5880 I/O PORT (18) at the timing explained in the preceding section.

For details on the data format, see Chapter 9.8 LOAD/SAVE Data Format Description.

(7) When the LBO-5880 is receiving control data from the external controller, 99. (Receiving in Address 99) is displayed on 7-segment LEDs (30) and (31).

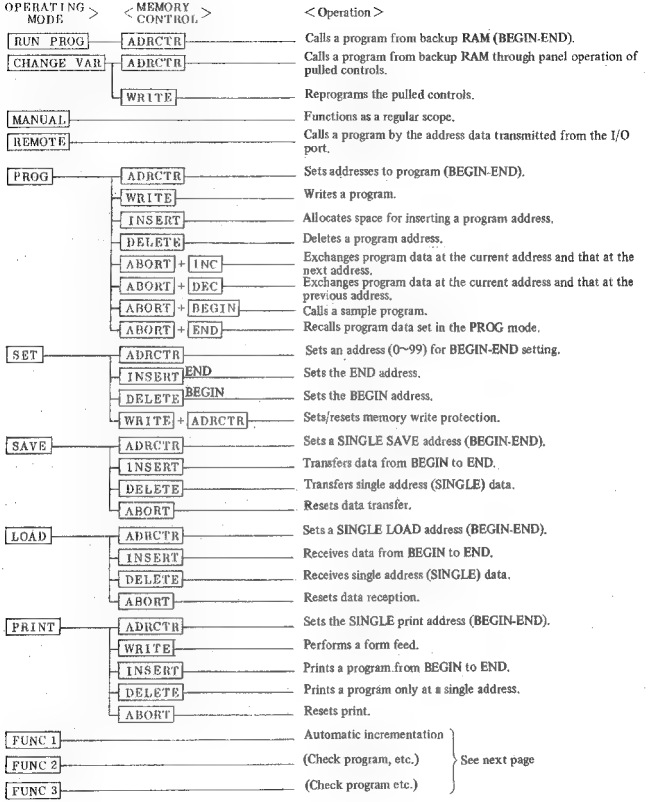
(8) Immediately after reception of single program address data, the oscilloscope function is switched according to the data, and C 1. (Control 1) is redisplayed on blinking 7-segment LEDs (30) and (31).

(9) When necessary to externally transmit additional single program address data to the LBO-5880, repeat from step (6) downward.

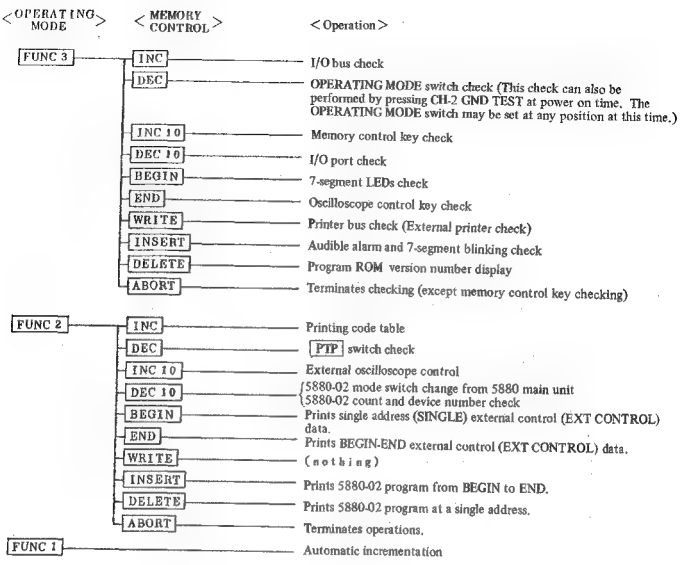
(10) To terminate external control in progress, press ABORT key (27), and F2 (FUNC 2) will be redisplayed on 7-segment LEDs (30) and (31) and the LBO-5880 returns to normal status.

11. OPERATION CHART AND LED DISPLAYS

The basic operations of the LBO-5880 are summarized in the following chart to facilitate understanding.



Note: ADRCTR denotes INC, DEC, INC 10, DEC 10, BEGIN, and END


<OPERATING MODE>
<MEMORY CONTROL>
<Operation>
FUNC 3
INC
I/O bus check
DEC
OPERATING MODE switch check (This check can also be performed by pressing CH-2 GND TEST at power on time. The OPERATING MODE switch may be set at any position at this time.)
INC 10
Memory control key check
DEC 10
I/O port check
BEGIN
7-segment LEDs check
END
Oscilloscope control key check
WRITE
Printer bus check (External printer check)
INSERT
Audible alarm and 7-segment blinking check
DELETE
Program ROM version number display
ABORT
Terminates checking (except memory control key checking)
FUNC 2
INC
Printing code table
DEC
PTP switch check
INC 10
External oscilloscope control
DEC 10
5880-02 mode switch change from 5880 main unit
5880-02 count and device number check
BEGIN
Prints single address (SINGLE) external control (EXT CONTROL) data.
END
Prints BEGIN-END external control (EXT CONTROL) data.
WRITE
(nothing)
INSERT
Prints 5880-02 program from BEGIN to END.
DELETE
Prints 5880-02 program at a single address.
ABORT
Terminates operations.
FUNC 1
Automatic incrementation

< 7-Segment LEDs >	Operation
	PROG ADDRESS 83 display
	Key entry error
	SAVE A mode (SINGLE)
	SAVE B mode (BEGIN/END)
	LOAD A mode (SINGLE)
	LOAD B mode (BEGIN/END)
	PRINT A mode (SINGLE)
	PRINT B mode (BEGIN/END)
	MANUAL mode
	REMOTE mode (Control mode 0)
	Memory write protection on (Protected)
	Memory write protection off (Unprotected)
	Error (#41)
	Automatic incrementation
	Code table printing (PRINT data table)
	PTP pulled switch check (Pull)
	Oscilloscope control (Control mode 1)
	No 5880-02 connected (Device = 0)
	One 5880-02 connected (Device = 1)
	Two 5880-02's connected (Device = 2)
	Three 5880-02's connected (Device = 3)
	Four 5880-02's connected (Device = 4)
	I/O BUS check successful
	I/O BUS check unsuccessful
	OPERATING MODE switch check
	Memory control key check
	I/O PORT check
	PRINTER BUS check (Print Character)
	Audible alarm and LED blinking check

LBO-5880 LED displays and operations

12. ERROR MESSAGES

12.1 Error Message Classifications

The LBO-5880 performs various checks during operation. Whenever errors are detected by these checks, it displays the appropriate error number on 7-segment LEDs (30) and (31). Errors vary in severity depending on the error number.

- Errors 0 ~ 19 are serious erros and indicate internal hardware faults. Once such an error occurs, it remains on display until ABORT key (27) is pressed.
  When ABORT key (27) is pressed, the error display is cleared and the LBO-5880 proceeds to the next operation. However, satisfactory performance is unpredictable until the hardware fault is recovered.
- Errors 20 ~ 99 are warning errors, which include invalid address settings and invalid external device connection errors.
  The LBO-5880 returns to normal operation flow when a predetermined time period (about 5 seconds) has elapsed after the error is displayed. Retry after reviewing and correcting the address settings or device connections.
- When ERROR LED (28) is turned on without an error number being displayed, this indicates that an invalid key was pressed to set OPERATION MODE switch (21). The LBO-5880 returns to normal operation flow after the error is displayed for about 1 second.

12.2 Error "28"

Error 28 has a more serious meaning than any warning error. It indicates faulty backup RAM data. This error is displayed when invalid data is present in the BACKUP RAM.
It may be related to the discharge of the backup battery (after a one month discontinuation of use, for example) or a faulty backup RAM.
The figure displayed prior to error 28 indicates the program address in error.
For example, if 10 → 11 → 28 are displayed in this order, program addresses 10 and 11 are erroneous; if 28 → 30 → 56 → 99 → 28 are displayed in this order, program addresses 28, 30, 56, and 99 are erroneous.
Note: The data at program addresses indicated in error is cleared to prevent malfunction.

12.3 Error Codes

< Serious erros >

Error number	
0 0	A/D converter not READY
0 1	
0 2	D/A converter not READY
0 3	
0 4	
0 5	
0 6	
0 7	Faulty RAM 4
0 8	
0 9	
1 0	Faulty operating mode switch
1 1	Faulty memory control key
1 2	Faulty panel control key
1 3	
1 4	
1 5	
1 6	
1 7	
1 8	
1 9	

< Warning errors >

Error number	
2 0	The current oscilloscope is set in the SAVE mode, but the remote oscilloscope is not READY.
2 1	Response from the remote oscilloscope was terminated during SAVE.
2 2	The current oscilloscope is ready in the LOAD mode, but no data is sent from the remote oscilloscope.
2 3	Data transmission from the remote oscilloscope was interrupted during LOAD.
2 4	The current oscilloscope attempted to send data in the SAVE mode, but the remote oscilloscope's port is not in the input mode.
2 5	Invalid data exists among the loaded data.
2 6	The printer is not READY in the PRINT mode.
2 7	The printer entered not READY status while printing.
2 8	Invalid BACKUP RAM data.
2 9	The END address was exceeded during LOAD.
3 0	The remote oscilloscope is also in the LOAD mode.
3 1	A start mark was entered in the middle of loaded data.
3 2	The remote address exceeded 99.
3 3	BEGIN $\geq$ END was set.
3 4	Exchanging with over address 99 was attempted.
3 5	Exchanging with less than address 0 was attempted.
3 6	The port was active when remote address BINARY code was sent.
3 7	The port was active when remote address BCD code was sent.
3 8	The port was active when remote enable was sent.
3 9	The printer remains READY while printing.

4 0	Deletion of program data at the END address was attempted.
4 1	Writing to write-protected memory was attempted.
4 2	WRITE protection was not set because its setting was interrupted.
4 3	WRITE protection was not reset because its resetting was interrupted.
4 4	The backup BEGIN address is greater than or equal to the END address.
4 5	The backup END address is greater than 99.
4 6	The backup current address is outside the BEGIN-END address range.
4 7	The high order digit of the BCD remote address is greater than 9.
4 8	The low order digit of the BCD remote address is greater than 9.
4 9	The current oscilloscope attempted to enter the SAVE mode, but the remote oscilloscope's STROBE port is not in the input mode.
5 0	The current oscilloscope attempted to enter the SAVE mode, but the remote oscilloscope remains ready.
5 1	The current oscilloscope attempted to enter the SAVE mode, but the remote oscilloscope became ready during SAVE.
5 2	STROBE received from the remote oscilloscope in the LOAD mode became low.
5 3	STROBE received from the remote oscilloscope in the LOAD mode became low during LOAD.
5 4	I/O port checking shows that data is being sent to the A port from another device.
5 5	I/O port checking shows that data is being sent to the B port from another device.
5 6	I/O port checking shows that data is being sent to the C port from another device.
5 7	Pull SW checking shows that data is being sent to the A port from another device.
5 8	Pull SW checking shows that data is being sent to the B port from another device.
5 9	Pull SW checking shows that data is being sent to the C port from another device.
6 0	Address 99 used in the scope control mode is memory-protected.
6 1	Output P and Q of LBO-5880-02 are in the same mode (4CH X 2 modes).
6 2	Invalid LBO-5880-02 mode data.
6 3	LBO-5880-02 was turned off halfway.
6 4	For an expanded LBO-5880-02 configuration, there are two or more devices in the 4CH X 2 or 8CH X 1 mode, and in the same output mode.
6 5	For an expanded LBO-5880-02 configuration, a device in the 4CH X 2 mode is followed by another device in the 10CH X 1 mode, and in the same output mode.
6 6	For an expanded LBO-5880-02 configuration, a device in the 8CH X 1 mode is followed by another device in the 10CH X 1 mode, and in the same output mode.
6 7	
6 8	
6 9	
7 0	
9 9	

13. PRINTING EXTERNAL CONTROL (EXT CONTROL DATA) FUNC 2 + BEGIN or END

This section applies to internal ROM program versions 1.4 and later versions.

The LBO-5880 has a maximum of 64-bit memory spaces that are accessible to an external device as well as to the oscilloscope main unit. The contents of this memory space are covered in Chapter 9.12 External Control (EXT CONTROL) Procedures.
This section explains how to print the program in the EXT area on an external printer.
Two methods of printing can be used: continuous printing of memory contents between the preset BEGIN and END addresses, and printing only the memory contents at the current address displayed on the LEDs.

13.1 BEGIN-END Printing FUNC 2 + END

(1) Perform the setup described in Chapter 9.9.1. This is not necessary if a print operation has previously been started.
(2) Set OPERATING MODE switch (22) to SET, and set the BEGIN and END addresses to print. (See Chapter 9.1 Setting BEGIN and END address for instructions.)
(3) Set OPERATING MODE switch (22) to FUNC 2.
(4) Press END key (37) and Pb. will be displayed on LEDs (30) and (31) before the following title is printed. This title is not printed, however, unless the top of forms is reached, if the current program data is to be printed immediately following the prior printing.

Note principal signal names here.

```
--- LEADER / LBO-5880 PROGRAM LIST ---          SER. NO.(        )    PAGE (  /  )
PROG NAME (                                  ),MODEL NO.(          ),PROG NO.(      )
SECTION (      ),PROGRAMMER (                ),DATE (  /  /  ),COMMENT (             )
          (      ) (      ) (      ) (      ) (      ) (      ) (      ) (      )
    ( EXT0 ) ( EXT1 ) ( EXT2 ) ( EXT3 ) ( EXT4 ) ( EXT5 ) ( EXT6 ) ( EXT7 )
ADRS  76543210 76543210 76543210 76543210 76543210 76543210 76543210 76543210
```

(5) Then, the printer starts printing the program contents. The address being printed is displayed on blinking LEDs (30) and (31) . (Example: 39. Address 39 is being printed.)

```
33: 01111110 00001101 00101100 00111011 01001010 01011001 01101000 01110111
34: 01111101 00001100 01110111 00000110 00010101 00100100 00110011 01000010
35: 01000001 01010000 01011011 01101010 01111001 00001000 00010111 00100110
36: 00101010 00111001 00010000 00011111 00101110 00111101 01001100 01011011
37: 01100100 01110011 01100010 01110001 00000000 00001111 00011110 00101101
38: 01001111 01010110 00001001 00011000 00100111 00110110 01000101 01010100
39: 01100111 01110110 00001001 00011000 00100111 00110110 01000101 01010100
```

(6) Printing stops when the program contents have been printed up to the END address.
(7) Then, set OPERATING MODE switch (22) to PRINT and press WRITE key (24) . The printer will then perform a form feed to the next top of forms position.

(8) To print other BEGIN-END addresses, repeat from step (2) downward. (Step (7) is not necessary if new program data is to be printed immediately after the previous data.)

(9) A sample printed page is shown below.

(10) When the address to be printed contains 50 or more lines, the printer automatically performs a form feed and prints the title at the beginning of the next page before printing the rest of the address.

```
--- LEADER / LBO-5800 PROGRAM LIST ---          SER. NO.(          )     PAGE ( / )

PROG NAME (          ),MODEL NO.(          ),PROG NO.(          )
SECTION (          ),PROGRAMMER (          ),DATE ( / / ),COMMENT (          )

     [      ] [      ] [      ] [      ] [      ] [      ] [      ] [      ]

      < EXT0 > < EXT1 > < EXT2 > < EXT3 > < EXT4 > < EXT5 > < EXT6 > < EXT7 >
      76543210 76543210 76543210 76543210 76543210 76543210 76543210 76543210
ADRS
 00: 00010111 01110110 01000101 00110000 00001111 01101110 00111101 00011100
 01: 01101110 01000101 00110000 00001111 01000110 01100001 00110000 01101111
 02: 01111010 00001001 00011000 00100111 00110110 01000101 01010100 01100011
 03: 00010011 01101010 01111001 00001000 00010111 00100110 00110101 01000100
 04: 00000101 00010100 00100011 00110010 01000001 01010000 01011111 01101110
 05: 00111000 01000111 01010110 01100101 01110100 00000011 00010010 00100001
 06: 01111000 00000111 00010110 01111101 01111000 00000111 01100110 00110101
 07: 00100101 00000100 01010011 00110010 00011101 01111100 01001011 00101010
 08: 01101011 01000110 00110001 00010000 01011111 00111110 00011101 00001000
 09: 00111110 00101001 00001000 01010111 00110110 00100001 01110000 01001111
 10: 01101101 01111100 00000101 00011010 00101001 00111000 01000111 01010110
 11: 01110101 01101100 01111011 00001100 00011001 00101000 00110111 01000110
 12: 00111110 01110001 00000000 00001111 00011110 00101101 00111100 01001011
 13: 01010100 00111011 01001010 01011001 01101000 01110111 00000110 00010101
 14: 00001011 00101010 00110001 01000000 01001111 01011110 01101101 01111000
 15: 00000011 01010110 01100101 01110100 00000011 00010010 00100001 00110000
 16: 01001000 01100111 01111010 00001001 00011000 00100111 00110110 01000101
 17: 01010110 01100101 00101000 00110111 01000110 01010101 01100100 01110011
 18: 00000001 00011000 00111011 01001010 01011001 01100000 01110111 00000110
 19: 00100001 00110000 01110111 00000110 00010101 00100100 00110011 01000010
 20: 01111000 00000111 00110010 01000001 01010000 01011111 01101110 01111101
 21: 00101100 00111011 00110010 01000001 01010000 01011111 01101110 01111101
 22: 00110001 01000000 01011111 01101110 01111101 00001100 00011011 00101010
 23: 01101111 01111110 01111001 00001000 00010111 00100110 00110101 01000100
 24: 00000010 00010001 00111100 01001011 01011010 01100001 01111000 00000111
 25: 01001010 01011001 01001100 01011011 01101010 01111001 00001000 00010111
 26: 01011111 01101110 00100101 00110100 01000011 01010010 01100001 01100000
 27: 00111101 01001100 00001111 00011110 00101101 00111100 01001011 01011010
 28: 00111000 01000111 00010010 00100001 00110000 00111111 01001110 01011101
 29: 00110100 01000011 01000010 01010001 01100000 01101111 01111110 00001101
 30: 01110011 00000010 01100101 01110100 00000011 00010010 00100001 00110000
 31: 00011101 00101010 00110001 01000000 01001111 01011110 01101100 01111000
 32: 01101100 01111011 00111110 01001101 01011100 01100111 01111010 00001001
 33: 01111110 00001101 00101100 00111011 01001010 01011001 01101000 01110111
 34: 01111101 00001100 01110111 00000110 00010101 00100100 00110011 01000010
 35: 01000001 01010000 01011011 01101010 01111001 00001000 00010111 00100110
 36: 00101010 00111001 00010000 00011111 00101110 00111101 01001100 01011011
 37: 01100100 01110011 01100010 01110001 00000000 00001111 00011110 00101101
 38: 01000111 01010110 00001001 00011000 00100111 00110110 01000101 01010100
 39: 01100111 01110110 00001001 00011000 00100111 00110110 01000101 01010100
 40: 01110110 00000101 01101000 01110111 00000110 00010101 00100100 00110011
 41: 01010110 01100101 00010000 00011111 00101110 00111101 01001100 01011011
 42: 00010011 00100010 00111001 01001000 01010111 01100110 01110101 00000100
 43: 00110101 01000100 00110011 01000010 01010001 01100000 01101111 01111110
 44: 00110100 01000011 00000010 00010001 00100000 00101111 00111110 01001101
 45: 00001000 00010111 00000110 00010101 00100100 00110011 01000010 01010001
 46: 00010001 00100000 00110011 01000010 01010001 01100000 01101111 01111110
 47: 01000011 01010010 00011101 00101100 00111011 01001010 01011001 01101000
 48: 00110010 01000001 00001000 00010111 00100110 00110101 01000100 01010011
 49: 00100010 00110001 00110100 01000011 01010010 01100001 01110000 01111111
```

13.2 SINGLE Printing [FUNC 2] + [BEGIN]

(1) Perform the setup described in Chapter 9.9.1. This is not necessary if a print operation has previously been started.

(2) Set OPERATING MODE switch (22) to PRINT.

(3) Display the address to be printed on LEDs (30) and (31) by pressing INC (32), DEC (33), INC 10 (34), and DEC 10 (35).

(Note: The address to be printed can be displayed only when it is in the BEGIN-END address range. Otherwise, the BEGIN and END addresses must be reset by setting OPERATING MODE switch (22) to SET.)

(4) Set OPERATING MODE switch (22) to FUNC 2.

(5) Press SINGLE key (26) to start printing.

(Note: If the print position is at the top of forms, PA. is displayed on LEDs (30) and (31), and the same title as described in (4) is printed before the program is printed.)

The address being printed is displayed on blinking LEDs (30) and (31).

(6) When printing of the single address is completed, the address displayed on LEDs (30) and (31) is incremented by one.

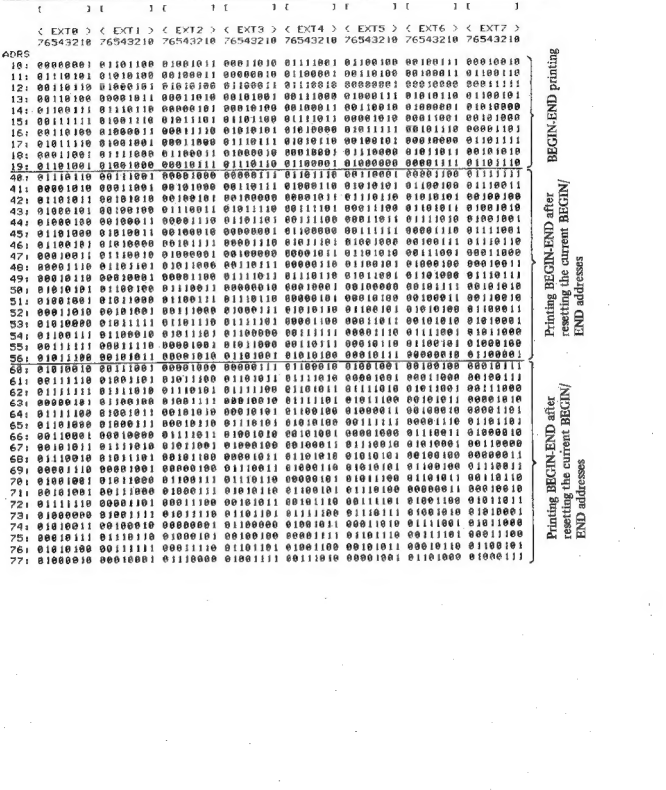
If BEGIN key is not pressed within about 10 seconds, however, F2 (FUNC 2) is displayed on the LEDs.

(7) To continue printing, repeat from step (2) downward, or from (5) downward to print consecutive addresses.

13.3 Print applications

BEGIN-END printing described in Chapter 13.1 and SINGLE printing described in Chapter 13.2 can be mixed as in the following sample operations:

```
--- LEADER / LBO-5880 PROGRAM LIST ---          SER. NO.(      )     PAGE (  /  )
PROG NAME (                    ),MODEL NO.(                    ),PROG NO.(      )
SECTION (      ),PROGRAMMER (          ),DATE (  /  /  ),COMMENT (                )
[      ][      ][      ][      ][      ][      ][      ][      ]
    ( EXT0 ) ( EXT1 ) ( EXT2 ) ( EXT3 ) ( EXT4 ) ( EXT5 ) ( EXT6 ) ( EXT7 )
    76543210 76543210 76543210 76543210 76543210 76543210 76543210 76543210
ADRS
 10: 00101010 00001001 01101000 00110111 00010110 00000001 01010000 00101111 ┐
 11: 00010010 01110001 01000000 00011111 01111110 01010001 01001100 00000011 │
 12: 01010011 01100010 01110001 00000000 00001111 00011110 00101101 00111100 │
 13: 01010001 00101000 00110111 01001110 01010101 01100100 01110011 00000010 │
 14: 00000100 00010011 00100010 00110001 01000000 01001111 01011110 01101101 │
 15: 01011100 01101011 01111010 00001001 00011000 00100111 00110110 01000101 │
 16: 01010001 01100000 00111011 01110010 01101101 01111100 01001011 00101010 │
 17: 01111011 01100110 00110101 00010100 01110011 01000010 00101101 00001100 │
 18: 00101110 00100001 00000000 01011111 00101110 00001101 01111000 01000111 │
 19: 00000110 01100101 00110100 00010011 01111110 01011101 00101100 00001011 ┘
 31: 01111000 01010011 00100010 00010101 01110000 01001011 00100110 00000001 ┐
 37: 00111100 00001011 01100110 01000001 00101000 00011011 01101010 00111001 │
 46: 00010010 00000101 01101100 01000111 00010110 01100001 01001100 00100111 │
 47: 00100010 00011001 01110100 01000011 00101010 00000101 01111000 01000111 │
 48: 01101000 01001111 00010010 00000101 01101100 00111011 00001010 01110001 │
 60: 01000111 00100010 00001001 01111100 00111111 01110110 00111001 00010100 │
 63: 00011100 01110111 00101110 01111101 01000000 00110011 00000010 00000001 │
 74: 01001111 00010010 01111001 01001000 00101111 01110010 01001101 00011100 │
 80: 00000001 00000000 01111111 00101010 00010001 01111000 01010011 00100010 │
 91: 00100011 00001010 01110001 01001100 00100111 01110110 01000101 00100000 │
 95: 01101111 00100110 00001101 01101000 01001111 00010010 01111001 00111001 │
 98: 01110010 01001101 00011100 01110111 00101110 00001001 01110000 01010111 │
 99: 00000000 00001011 01110010 01000001 00110100 00001111 01011110 00100001 ┘
                                                                  BEGIN-END printing
                                                                  SINGLE printing
```


--- LEADER / LBO-5800 PROGRAM LIST ---
SER. NO.(
PAGE (/)
PROG NAME (
),MODEL NO.(
),PROG NO.(
SECTION (
),PROGRAMMER (
),DATE (/ /),COMMENT (
< EXT0 > < EXT1 > < EXT2 > < EXT3 > < EXT4 > < EXT5 > < EXT6 > < EXT7 >
76543210 76543210 76543210 76543210 76543210 76543210 76543210 76543210
ADRS
BEGIN-END printing
Printing BEGIN-END after resetting the current BEGIN/END addresses
Printing BEGIN-END after resetting the current BEGIN/END addresses